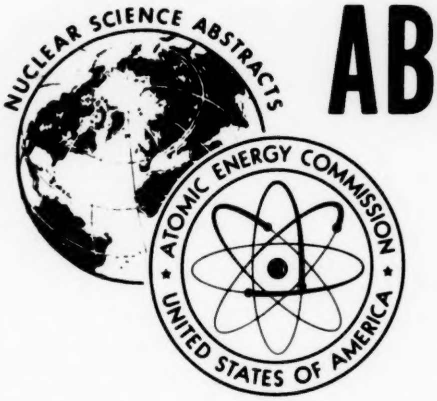
NUCLEAR SCIENCE ABSTRACTS


NUCLEAR SCIENCE ABSTRACTS
ATOMIC ENERGY COMMISSION
UNITED STATES OF AMERICA

Volume 25 Number 24

Abstracts 57297-60296

December 31, 1971

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Division of Technical Information

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NOTICE

A title page for Volume 25, Numbers 19–24, is included at the back of this issue for use in binding those issues.

CORRECTIONS

NSA Vol. 22, No. 18, Abst. 38195, lines 2 and 3 should read: LABELING OF PROTEINS]. [Walter L. Hughes; Samuel James Davidson] (Tufts Univ., Boston, Mass. School of Medi-

NSA Vol. 25, No. 9, Abst. 20815, line 1 should read: (DOCKET-50238-82) N. S. SAVANNAH. Safety

NSA Vol. 25, No. 11, Abst. 24328, line 16 should read: dose of tritium oxide of 0.08 mCi produced temporary suppression of

NSA Vol. 25, No. 11, Abst. 24329, line 12 should read: mCi of tritium oxide during various stages of pregnancy. The de-

NSA Vol. 25, No. 14, Abst. 32135, line 6 should read: piston ring wear.

NSA Vol. 25, No. 21, Abst. 49203, line 3 should read: Jan 1970. 461p. GPO $4.00.

NSA Vol. 25, No. 16, Replace abstracts 37686, 37687, and 37688 with the following abstracts:

37686 APPARATUS TO DETERMINE THE OPTICAL PROPERTIES IN THE EXTREME ULTRAVIOLET OF FILMS WHICH ARE EVAPORATED AND STORED IN ULTRA HIGH VACUUM (10^{-10} TORR). Daude, A.; Robin, S. (Univ., Rennes, France). Nouv. Rev. Opt. Appl.; 2: No. 1, 57-62(Jan-Feb 1971). (In French).

The optical properties of thin films depend chiefly upon the surrounding conditions of preparation and conservation. An apparatus permitting the determination of optical constants of materials evaporated in ultra high vacuum is described, a device of stockpiling and displacement of the samples allows to conserve and study 40 samples without exposing to air the different chambers. The thicknesses were measured during the evaporation by means of a piezoelectric quartz, the composition of the residual atmosphere being controlled by a quadrupolar gas analyser. Since no window is used between the source and the reflector, the apparatus can be used for any spectral region but principally it is realized for far ultraviolet. The receptor used at present is a Bendix M 306 photomultiplier without any window. The apparatus enables the measurement of transmittance and reflectance for the angles of incidence varying between 15 and 70° with a good precision. Some results of the measurements carried out with this apparatus for Al, Mg, and MgF_2 are given. (auth) (France)

37687 NEW TECHNIQUE FOR NEUTRON DIFFRACTION. USE OF WHITE RADIATION. Hubbard, C. R.; Quicksall, C. O.; Jacobson, R. A. (Ames Lab., Iowa). Nucl. Instrum. Methods; 94: No. 1, 185-6(1971).

A new diffraction method has been developed which uses a white neutron beam. With this method the efficiency of data collection is enhanced approximately one hundred fold. (auth)

37688 WEAPONS EFFECT DISPLAY SYSTEM. Berndt, Carl W.; Reinecker, Frederick Jr.; Downing, Willis G. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,558,865. 26 Jan 1971. Filed 31 Mar 1967.

A system for displaying simulated post-detonation "effects" of a nuclear device on a geographical map is described. The system comprises a geographical plotter and a multiplicity of analog computers for storing the functional relationships between yield characteristics of a nuclear device, manner of detonation, and environmental conditions on one hand, and the "effects" resulting from detonation on the other. In response to input signal data corresponding to the variables of these functional relationships, the analog computers issue output signals representative of the associated magnitudes and ranges of the "effects" and such range signals are simultaneously utilized to project and superimpose figures onto a geographical map by means of the plotter. The area on the map encompassed by each figure indicates the geographical extent subjected to the corresponding simulated nuclear detonation "effect." (auth)

XUM

Volume 25, Number 24, December 31, 1971

NUCLEAR SCIENCE ABSTRACTS

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Published by the USAEC Division of Technical Information Extension, Robert L. Shannon, Extension Manager.

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A list of the journals scanned regularly and the abbreviations used appears in Issue 1 (January 15) of each volume of *Nuclear Science Abstracts* and is supplemented in Issues 7, 13, and 19. Issue 1 of each volume also describes the scope and arrangement of the subject matter covered in *Nuclear Science Abstracts.* The subject matter covered is also described in TID-4552, *Subject Scope of Nuclear Science Abstracts,* available free from the USAEC Division of Technical Information Extension, P.O. Box 62, Oak Ridge, Tennessee 37830. An outline of the subject categories appears in the Contents of each issue.

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Personal Authors

Each author's name is indexed in the form appearing on the document abstracted:

NEWCOMB, William A., Stability of a magnetic well, 25:1239
NEWKIRK, L. R., Superconductivity in the pseudobinary alloys V_3Si--Nb_3Al, 25:1093 (CALT-822-13)
NEWLAND, E. A., Radiation treatment of sewage, 25:140 (AAEC/LIB/Bib-254)

Subjects

The subject index consisting of specific materials, objects, and processes is arranged alphabetically. Modifying phrases specific to these subjects in turn are arranged alphabetically under the subjects.

TRANSURANIUM ELEMENTS
determination in bone ash, radiochemical method for, 25:40 (IDO-12073, pp 28-36)
separation by ion exchange and complex-formation elution, 25:251(P)

TRIETHYLENETETRAMINE
complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137

TRITIUM
content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
determination in luminescent material by scintillation counting, 25:40 (IDO-12073, pp 28-36)

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Technical report literature is indexed from the name of the organization or institution responsible for the issuance of the report.

372 (UCRL-72739) CONSTRUCTION OF A UNIQUE UNDERGROUND WHOLE BODY COUNTER. Griffith, R. V.; Anderson, A. L.; Lindeken, C. L. **(California Univ., Livermore. Lawrence Radiation Lab.).** Oct 1970. 27p. (CONF-701009-1). Dep. NTIS.

is indexed as:

CALIFORNIA UNIV., LIVERMORE. LAWRENCE RADIATION LAB.
Construction of a unique underground whole body counter, 25:372 (UCRL-72739)

Report Numbers

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ORNL-		
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ORNL-IBP-		
70-3	25-2025	Dep. NTIS
ORNL-IIC-		
21	25-261	Dep. NTIS
30(Pt.2)	25-331	Dep. NTIS
ORNL-NSIC-		
78	25-1912	Dep. NTIS

TABLE OF CONTENTS

Volume 25, Number 24, December 31, 1971

Category *Page*

CHEMISTRY 5639
Analytical Chemistry 5639
Chemical and Spectral Procedures 5639
Isotope Dilution Procedures 5643
Radiometric and Radiochemical Procedures 5643
Activation Procedures 5646
Inorganic, Organic, and Physical Chemistry 5648
Chemical Properties 5648
Isotope Effects and Exchange 5650
Physical Chemistry 5652
Radiation and Nuclear Chemistry 5653
Radiation Effects 5653
Radiation Processes 5653
Radiolysis 5654
Radioisotope Production 5656
Recoil Production and Reactions 5657
Radiochemistry 5658
Separation Processes 5658

EARTH SCIENCES 5665
Geology and Hydrology 5665
Meteorology 5666
Mineralogy and Exploration 5667
Oceanography 5668
Seismology 5668

ENGINEERING 5670
Nuclear Explosions 5670
Facilities and Equipment 5670
Heat Transfer and Fluid Flow 5673
Isotope Technology 5675
Materials Testing 5678
Protective Structures 5680
Radioactive Material Handling 5680
Vacuum Engineering 5682

INSTRUMENTATION 5683
Radiation Detection Instruments 5683
General Detectors and Monitors 5683
Nuclear Spectroscopic Instrumentation 5691
High Energy Physics Instrumentation 5694
Radiation Dosimeters 5694
Radiometric Instruments 5699
Miscellaneous Instruments and Components 5700
Radiation Effects on Instruments and Instrument Components 5703

LIFE SCIENCES 5705
Biochemistry, Physiology, and Molecular Biology 5705
Basic Processes 5705
Metabolism, Physiology, and Toxicology 5705
Radiation Effects 5706
Immunology 5709
Ecology 5709
Genetics and Cytogenetics 5710
Health Physics and Safety 5714
Radioactive Contamination and Decontamination 5714
Dosimetry and Monitoring 5715
Radiation Protection 5719
Safety Procedures 5719

Category *Page*

LIFE SCIENCES (Cont'd.)

Legal Aspects 5719
Medicine 5719
Protective Substances 5720
Radiation Sickness and Injuries 5720
Radiodiagnosis 5721
Radiotherapy 5723
Blast and Thermal Effects 5725
Radiation Effects on Animals 5725
Invertebrates 5726
Vertebrates 5727
Man 5732
Radiation Effects on Plants 5734
Radiation Effects on Microorganisms 5734
Radiosterilization and Radiopreservation 5735

METALS, CERAMICS, AND OTHER MATERIALS 5736
Metals and Alloys 5736
Corrosion and Erosion 5736
Preparation and Fabrication 5737
Properties Evaluations 5740
Structure and Phase Studies 5747
Radiation Effects 5749
Ceramics and Cermets 5754
Corrosion and Erosion 5755
Preparation and Fabrication 5755
Properties Evaluations 5757
Structure and Phase Studies 5759
Radiation Effects 5761
Plastics and Other Materials 5762

PHYSICS (GENERAL) 5763
Astrophysics and Cosmology 5763
Cosmic Ray Exposure Ages 5763
Stars 5763
Quasi-Stellar, Radio, and X-Ray Sources 5771
Solar Phenomena 5775
Galaxies 5780
Cosmology 5784
Planetary Phenomena 5785
Atomic and Molecular Physics 5786
Atomic, Electron, Ion, and Molecular Beams and Their Reactions 5786
Atomic and Molecular Properties 5788
Positronium, Muonium, and Mesic Atoms and Molecules 5790
Collision Phenomena 5790
Atomic Theory 5797
Cosmic Radiation 5801
Direct Energy Conversion 5802
Fluid Physics 5803
Geophysics (Upper Atmosphere) 5804
Low-Temperature Physics and Cryogenic Equipment 5811
Superfluidity 5811
Superconductivity 5812
Equipment and Devices 5815
Plasma and Thermonuclear Physics 5815
Confinement and Heating 5815
Diagnostics 5817

TABLE OF CONTENTS (continued)

Category *Page*

PHYSICS (GENERAL) (Cont'd.)

- *Kinetics (General)* 5819
- *Kinetics (Experimental)* 5820
- *Kinetics (Theoretical)* 5822
- *Production* 5824
- *Stability* 5824
- *Thermonuclear Processes* 5826
- *Wave Phenomena* 5826
- Shielding 5828
- Solid-State Physics 5831
  - *Radiation Effects* 5831
  - *Physical Properties* 5836
  - *Moessbauer Effects and NMR* 5838
  - *Theory* 5839
- Theoretical Physics 5839

PHYSICS (HIGH-ENERGY) 5843
- Particle Interactions and Properties (Experimental) 5843
  - *Electromagnetic* 5843
  - *Weak* 5844
  - *Strong (Baryon-Induced)* 5845
  - *Strong (Meson-Induced)* 5847
- Particle Interactions and Properties (Theoretical) 5851
  - *General* 5851
  - *Electromagnetic* 5851
  - *Weak* 5856
  - *Strong (General)* 5859
  - *Strong (Baryon No. = 0)* 5861
  - *Strong (Baryon No. = 1)* 5862
  - *Strong (Baryon No. ≥ 2)* 5865
- Particle Invariance Principles and Symmetries 5867
  - *General* 5868
  - *Applications (Electromagnetic and Weak)* 5868
  - *Applications (Strong)* 5869
- Field Theories 5870
  - *General* 5870
  - *Quantum Field Theory* 5870
  - *Gravitation and General Relativity* 5872
- Scattering Theory 5875
- Particle Accelerators 5877

PHYSICS (NUCLEAR) 5881
- Neutron Interactions with Matter 5881
- Nuclear Properties and Reactions, $A \leq 5$ 5883

PHYSICS (NUCLEAR) (Cont'd.)

- Nuclear Properties and Reactions, $6 \leq A \leq 19$ 5884
- Nuclear Properties and Reactions, $20 \leq A \leq 89$ 5886
- Nuclear Properties and Reactions, $A \geq 90$ 5889
- Nuclear Theory 5894

REACTOR TECHNOLOGY 5901
- Commercial Power Reactors 5901
  - *Operation and Economics* 5903
  - *Safety and Siting* 5905
- Power Reactor Development 5908
  - *Kinetics and Dynamics* 5911
  - *Control Systems* 5912
  - *Shielding* 5913
  - *Cooling Systems* 5913
  - *Fuels* 5916
  - *Auxiliary and Emergency Systems* 5916
  - *Operation and Economics* 5917
  - *Safety and Siting* 5919
  - *Power Conversion Systems* 5921
- Research and Test Reactors 5922
- Rocket and Space Reactors 5926
- Process Heat and Desalination Reactors 5927
- Marine and Portable Power Reactors 5927
- Production Reactors 5928
- Reactor Theory 5928
  - *Kinetics* 5930
  - *Dynamics* 5932
  - *Experimental Applications* 5932
- Reactor Components, Fuels, and Accessories 5932

GENERAL 5934

CORPORATE AUTHOR INDEX INDEX-1

PERSONAL AUTHOR INDEX INDEX-10

SUBJECT INDEX INDEX-71

REPORT NUMBER INDEX INDEX-172

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Volume 25, Number 24, December 31, 1971

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 57704 and 60058.

57297 (NBS-SPEC. PUBL.-260-30) STANDARD REFERENCE MATERIALS: STANDARD SAMPLES ISSUED IN THE USSR. Gorozhanina, R. S.; Freedman, A. Y.; Shaievitch, A. B. Translated by M. C. Selby (National Bureau of Standards, Boulder, Colo.), from the Russian. 82p. GPO $1.00.

Information is presented on standard samples of properties and composition of substances and materials including areas of their application, nomenclature, certified characteristics, and values of the certified quantities. (auth)

57298 (ORNL-4676, pp 73-138) CHEMISTRY. (Oak Ridge National Lab., Tenn.). Aug 1971.

In Molten-Salt Reactor Program semiannual progress report for period ending February 28, 1971.

BERYLLIUM FLUORIDES—BeF_2-LiF, thermodynamic properties of molten
 —BeF_2-NaF, phase transitions in molten
 —spectra in molten fluorides, Raman
BORON FLUORIDES—solubility of gaseous, in fluoride melts
CESIUM—separation from MSBR fuel solvent by reductive extraction
CESIUM URANIUM FLUORIDES—crystal structure
FUSED SALTS—sound velocity in, effects of entropy on
HELIUM—solubility in molten lithium beryllium fluorides
HYDROGEN—determination in MSRE pump bowl gas
 —diffusion through oxide-coated metals
 —solubility in molten lithium beryllium fluorides
INCONEL—corrosion by molten sodium fluoride–sodium fluoroborate solution
LITHIUM BERYLLIUM FLUORIDES—reactions of molybdenum or niobium fluorides in molten, kinetics of
 —solvent properties of molten, for helium and hydrogen
LITHIUM FLUORIDES—BeF_2-LiF, solvent properties of molten, for gaseous boron trifluoride
 —$BeF_2-LiF-ThF_4$, separation of cesium and rubidium from, by reductive extraction
LITHIUM MOLYBDENUM FLUORIDES—crystal structure
METALS—diffusion of hydrogen through oxide-coated
MOLTEN SALT BREEDER REACTOR—fuel reprocessing for
MOLTEN SALT REACTOR EXPERIMENT—fission product chemistry in
 —fuel pump bowl in, examination of deposits from mist shield in
MOLYBDENUM FLUORIDES—reactions in molten lithium beryllium fluoride solutions, kinetics of
NIOBIUM FLUORIDES—disproportionation of NbF_4
 —reactions in molten lithium beryllium fluoride solutions, kinetics of
 —mass spectra of
POTASSIUM THORIUM FLUORIDES—crystal structure
PROTACTINIUM—redox potential of, in MSBR fuel solvent salt
RARE EARTHS—separation from MSBR fuel by extraction
REACTOR FUELS—chemistry of molten salt
RUBIDIUM—separation from MSBR fuel solvent by reductive extraction
RUBIDIUM FLUOROBORATES—$RbBF_4-RbF$, phase diagram of
RUBIDIUM THORIUM FLUORIDES—crystal structure
RUBIDIUM ZIRCONIUM FLUORIDES—crystal structure
SODIUM FLUORIDES—$NaBF_4-NaF$, reactions of molten, with water
 —$NaBF_4-NaF$, corrosive effects of molten, on Inconel
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 —BeF_2-NaF, electric conductivity of molten and supercooled
SODIUM FLUOROBORATES—analysis of molten, for hydrogen- and deuterium-containing impurities, spectroscopic
 —spectra of polycrystalline, Raman
TRITIUM—determination in MSRE pump bowl gas
 —exchange with bound hydrogen in fluoroborate coolants
URANIUM FLUORIDES UF_4—enthalpy at 298 to 1400°K
URANIUM FLUORIDES UF_5—disproportionation equilibrium of solutions of (M.C.G.)

57299 THIN-LAYER ELECTROPHORESIS IN INORGANIC ANALYSIS. COMMUNICATION I. SEPARATION OF CERTAIN RARE EARTHS IN COMPLEXONE III SOLUTIONS. Makarova, T. P.; Stepanov, A. V. Zh. Anal. Khim.; 26: No. 9, 1823-5(Sep 1971). (In Russian).

The separation of microamounts of certain rare earths (Ce, Pm, Eu) in a Complexon III solution can be carried out by low-voltage thin-layer ionophoresis on silica gel and cellulose under conditions similar to those in the method of electromigration on paper. The results of the separation of elements depend on the peculiarities of various sorbents. Cellulose powders are more effective than silica gel. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 57890 and 60093.

57300 (ORO-3847-2) STUDY OF PARTICULATE HETEROGENEITY EFFECTS IN RADIOISOTOPE X-RAY SPECTROMETRY. Berry, P. F. (Nuclear-Chicago Corp., Austin, Tex. Texas Nuclear Div.). 3 Jun 1971. Contract AT(40-1)-3847. 107p. Dep. NTIS.

Theories of particle size effects on x-ray interaction phenomena are reviewed and a new model which provides experimentally consistent formulas for x-ray fluorescence, transmission, and back-scattered radiation intensities in granular materials and slurries is developed. The new model is applicable to homogeneous and dissimilar size particle mixtures. The applicability of radiometric methods of particle size analysis was investigated for selected matrices. Methods hitherto proposed, such as dual x-ray fluorescence and transmission, were examined in particular with regard to the mutual influences of particle size, chemical composition, and (slurry) solids content. In mixtures of particles of equal size, size determination independent of chemical composition was shown feasible by appropriate choice of x-ray energies. The practicality of these techniques, however, appears questionable for dissimilar size particle mixtures. (auth)

57301 (TID-25776) NATURAL CESIUM IN SEA WATER. Folsom, T. R.; Hansen, N. (Scripps Institution of Oceanography, La Jolla, Calif.); Robertson, D. E. (Battelle Pacific Northwest Labs., Richland, Wash.). 18 Aug 1970. 9p. Dep. NTIS.

A method is presented for the determination of cesium in sea-water that involves treating two 1-liter samples together, one having 0.500 μg ^{133}Cs added. The cesium is precipitated by ammonium 12-molybdophosphate (AMP), and extracted into TBP, then burned in a burning cup in a recording differential emission

XUM

photometer. Long storage of seawater samples in polyethylene has little effects (less than 3%) on cesium content. (D.H.M.)

57302 PLATINUM-GRAPHITE ELECTRODE SYSTEM FOR THE BIAMPEROMETRIC DETERMINATION OF IODINE. Prasad, B. B.; Khandelwal, G. D. (Banaras Hindu Univ., India). Z. Anal. Chem.; 253: No. 2, 123-4(1971).

An investigation was made of wax-impregnated graphite electrodes in combination with platinum for the biamperometric determination of iodine. Errors of 0.3 to 1% were found. (M.C.G.)

57303 BEHAVIOUR OF HALIDE IONS TOWARDS CHLORAMINE-T IN QUALITATIVE ANALYSIS. Rao, V. R. S. (Indian Inst. of Tech., Madras). Z. Anal. Chem.; 253: No. 2, 128(1971).

The study of behavior of halides towards Chloramine-T was undertaken. Fluoride was inert in all media; chloride was inert at pH 2 to 14, but oxidized and chlorine evolved in strong acid medium. Bromide destroys all Chloramine-T in the pH range 2.65 to 5.0; above pH 5, bromine is not reacted by Chloramine-T. Iodine can be determined in 2 to 4 M HCl medium and bromine can be determined in HCl or H_2SO_4. Iodide is oxidized to iodine in all media from strongly acid to pH 6. (M.C.G.)

57304 HIGHLY SELECTIVE AND RAPID SPECTROPHOTOMETRIC DETERMINATION OF Ca BY EXTRACTION OF THE Ca-GLYOXAL-BIS(2-HYDROXYANIL) COMPLEX WITH A MIXTURE OF 1-OCTANOL AND 2-OCTANOL. Keil, R. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Z. Anal. Chem.; 253: No. 1, 15-19(1971). (In German).

A rapid and simple procedure for the spectrophotometric determination of Ca using glyoxal-bis(2-hydroxyanil) is described. The red colored complex is extracted from an alkaline solution (0.4 to at least 1.5 N NaOH) into an organic phase consisting of 1-octanol and 2-octanol (volume ratio 1:4). After extraction the color of the organic phase is stable for at least 1 hr and can be measured at 545 nm. The selectivity of the method is increased by masking with KCN and by removing of interfering cations with ammonium pyrrolidinedithiocarbamate and phenylarsonic acid, respectively. Larger quantities of Ba and Sr are separated with sodium rhodizonate at pH 4.5. The determination of Ca in the presence of 60 cations and 19 anions was investigated. (auth)

57305 DETERMINATION OF URANIUM CONTENT AND UO_2 STOICHIOMETRY IN ThO_2–UO_2 NUCLEAR FUELS. Neeb, K. H.; Neidl, H. (Siemens AG, Erlangen, Ger.). Z. Anal. Chem.; 253: No. 1, 29-31(1971). (In German).

Analysis for uranium and UO_2 stoichiometry in 2.5 to 5% UO_2-containing ThO_2-UO_2 fuels is made in a single procedure by controlled-potential coulometry. Samples are dissolved in phosphoric acid–hydrofluoric acid with the addition of $Al_2(SO_4)_3$. With sample weights from 0.2 to 2 g the uranium content is determined with a relative standard deviation of 1%. The minimum detectable hyperstoichiometry of UO_3 amounts to 2.004 with a standard deviation of 0.002. (auth)

57306 ATOMIC ABSORPTION SPECTROPHOTOMETRIC DETERMINATION OF MOLYBDENUM IN FERTILIZERS. Koirtyohann, S. R.; Hamilton, Maureen (Univ. of Missouri, Columbia). J. Ass. Offic. Anal. Chem.; 54: No. 4, 787-9(Jul 1971).

Molybdenum is extracted into chloroform from fertilizer sample solutions at pH 1.6 as the 8-hydroxyquinolate. Atomic absorption in the premixed nitrous oxide–acetylene flame is used for determination. Methyl isoamyl ketone is added to the chloroform extract to improve the burning qualities. The method is sensitive and precise but appears to have a positive bias of about 5%. (auth)

57307 POLAROGRAPHIC DETERMINATION OF Cd, Co, Mn, Zn, Te(IV), and Cr(VI) IN SODIUM AZIDE SOLUTION. Rao, A. L. J.; Puri, B. K. (Punjabi Univ., Patiala, India). Z. Anal. Chem.; 254: No. 5, 362-3(1971).

Sodium azide was used as a supporting electrolyte for studying the polarographic characteristics of Cd, Co, Mn, Zn, Te, and Cr at a dropping mercury electrode. The plot of log $i/i_d - i$ versus E gave straight lines in all the cases and the value of the slopes in the cases of Zn, Cd, and Mn indicated that these metals undergo reversible reduction with two-electron change and the value of the slopes in case of Co, Cr, and Te corresponded to an irreversible reduction. (M.C.G.)

57308 GRAVIMETRIC DETERMINATION OF MOLYBDENUM(VI) WITH SALICYLHYDROXAMIC ACID. Chaudhuri, Nirmal K.; Sarkar, Ajit K.; Das, Jyotirmoy (Univ. of Burdwan, Bengal, India). Z. Anal. Chem.; 254: No. 5, 365-6(1971).

This reagent forms an insoluble yellow complex with molybdenum (VI) of the formula $MoO_2(C_7H_6O_3N)_2$, which can be weighed directly. (M.C.G.)

57309 TITRIMETRIC DETERMINATION OF IRON(II), MOLYBDENUM(V), AND THALLIUM(I) WITH POTASSIUM CHLORATE TO A POTENTIOMETRIC END-POINT. Radhakrishnamurty, C.; Gopala Rao, G. (Andhra Univ., Waltair, India). Z. Anal. Chem.; 254: No. 5, 366-7(1971).

The reactions of potassium chlorate are strongly catalyzed by hydrogen ions. Advantage was taken of this fact in developing titrimetric procedures for the determination of iron(II), molybdenum(V), and thallium(I). In these reactions it was observed that potassium chlorate functions as a 6-electron accepting oxidizing agent. (M.C.G.)

57310 STRONTIUM CONCENTRATIONS AND STRONTIUM-CHLORINITY RATIOS IN SEA WATER OF THE NORTH PACIFIC AND THE ADJACENT SEAS OF JAPAN. Nagaya, Yutaka; Nakamura, Kiyoshi; Saiki, Masamichi (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Kaiyo Gakkaishi; 27: No. 1, 20-6(Feb 1971).

Strontium contents of 232 seawater samples collected at various stations in the North Pacific and adjacent seas of Japan were measured by atomic absorption spectrophotometry and strontium: chlorine ratios were determined. The mean Sr concentration was 8.08 mg/kg and mean Sr/Cl ratio was 0.425 mg/kg/‰. Contrary to some recent reports, regional and vertical variations of Sr/Cl ratios were statistically insignificant, and the presence of particulate strontium was not confirmed. (auth) (Japan)

57311 POLAROGRAPHIC DETERMINATION OF Bi, Cu, Pb, Cd, Zn AS IMPURITIES IN RARE EARTH PREPARATIONS. Il'kova, S. B.; Zazimko, E. A. Zh. Anal. Khim.; 26: No. 8, 1660-1(Aug 1971). (In Russian).

Polarographic reduction of Bi, Cu, Pb, and Cd occurs reversibly in the presence of a large (up to 20 to 40 g/liter) excess of the rare earths. The reversibility of zinc reduction in the presence of the rare earths is broken. Methods were developed for determining Bi, Cu, Pd, and Cd in specially pure rare earth oxides with a sensitivity of 2×10^{-5}% and for determining zinc with a sensitivity of 2×10^{-3}% in rare earth oxides and with a sensitivity of 0.01% in europium oxide. The variation coefficients for the determination of 1×10^{-2} to 2×10^{-5}% of elements are within 12 to 21%. (auth)

57312 GROUP CONCENTRATION OF ELEMENTS BY EXTRACTION WITH A HYDROXYQUINOLINE MELT. Lobanov, F. I.; Buyanovskaya, A. G.; Gibalo, I. M. (Moscow State Univ.). Zh. Anal. Khim.; 26: No. 8, 1655-7(Aug 1971). (In Russian).

Group concentration of Cu, Ag, Au, Zn, Al, Ga, Zr, Pb, Sb, Bi, Cr, Mn, Fe, Co, and Ni ions by means of a hydroxyquinoline melt is possible. The method of the group concentration of ions of certain metals is combined with their spectrographic determination. The analysis of sodium hypophosphite for impurities of certain elements was carried out. (auth)

57313 SPECTROGRAPHIC METHOD FOR DETERMINING MAIN COMPONENTS IN ALLOYS BASED ON COBALT. Muzgin, V. N.; Pupyshev, A. A.; Antonov, A. V. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Anal. Khim.; 26: No. 8, 1589-92(Aug 1971). (In Russian).

The possibility was shown of determining main components in cobalt-base alloys by emission spectrography. The accuracy of the method was increased by using a stable excitation source, by feeding the analyzed samples as solutions into the excitation zone, and by using the regularities in changes of the sample composition. Methods were developed for the analysis of samarium–cobalt, praseodymium–cobalt, and samarium–nickel–cobalt alloys for the main components. The mean relative error of the methods is 0.5 to 2.0%. (auth)

57314 POTENTIAL OF A SILVER HALIDE ELECTRODE IN A FLOW UNDER THE CONDITIONS OF COMPLEX FORMATION. POTENTIOMETRIC DETERMINATION OF MICROCONCENTRATIONS OF IODIDE IONS. Bardin, V. V.; Tolstousov, V. N. (Leningrad Technological Inst.). Zh. Anal. Khim.; 26: No. 8, 1580-4(Aug 1971). (In Russian).

Equations were derived for the potential of a silver halide electrode in a laminar flow under the conditions of complex formation when there are either halide or silver ions in the solution. The equations were checked experimentally taking as an example a silver iodide electrode washed by an ammonia supporting electrolyte. In the range of small concentrations of iodide or $Ag(NH_3)_2^+$ ions the potential of the silver iodide electrode is a linear function of the concentration of the above ions. A method is suggested for determining iodide ions and silver with a sensitivity about 10^{-6} g/liter. The determination can be carried out in the presence of large amounts of certain anions which form difficultly soluble silver compounds. The method was used for determining microimpurities of iodides in KCl, KBr, and KIO_3 preparations. (auth)

57315 PHOTOMETRIC DETERMINATION OF NIOBIUM WITH MAGNESON. Elinson, S. V.; Nezhnova, T. I. Zh. Anal. Khim.; 26: No. 8, 1535-9(Aug 1971). (In Russian).

Magneson was studied as a reagent for niobium. A colored complex is formed in a tartrate solution. The absorption maximum of the complex is at the HCl concentration of 1 to 2 N. Niobium reacts with magneson at a molar ratio of 1 : 1, the molar extinction coefficient of the complex is $1.6 \cdot 10^4$, the apparent dissociation constant is $K_{dis} = (3.08 \pm 0.9) \cdot 10^{-28}$. The method with magneson was applied to the determination of niobium in alloys based on copper, iron, and zirconium. (auth)

57316 MIXED COMPLEX COMPOUNDS OF NIOBIUM WITH POLYPHENOLS AND ORGANIC BASES. Gibalo, I. M.; Eremina, G. V. (Moscow State Univ.). Zh. Anal. Khim.; 26: No. 8, 1531-4(Aug 1971). (In Russian).

Mixed complex compounds are formed in 8 to 9 M HCl at concentrations of 10^{-2} M of diantipyrylpropylmethane (DAPPM), 0.1 M of pyrocatechol (PC), and 0.2 M of pyrogallol (PG). These complex compounds Nb–DAPPM–PC and Nb–DAPPM–PG are soluble in 8 to 9 M HCl and can be extracted with organic solvents. The absorption spectra of the chloroform extracts of the Nb–DAPPM–PG compound have the maximum absorption band at 380 to 390 nm, $\epsilon = (14.1 \pm 0.7) \cdot 10^3$, that of the Nb–DAPPM–PC compound is at 390 to 400 nm, $\epsilon = (11.9 \pm 0.5) \cdot 10^3$. The molar ratios Nb : DAPPM : PC(PG) = 1 : 2 : 2 were established by the equilibrium shift method. The extraction of these compounds with organic solvents of various classes was studied. The best solvents are chloroform and benzene. Niobium can be determined in the presence of 20- to 30-fold amounts of titanium and 3- to 5-fold amounts of tantalum. (auth)

57317 USE OF A TERBIUM COMPLEX WITH 1,2-DIHYDROXYBENZENE-3,5-DISULFONIC ACID AS A LUMINESCENT INDICATOR IN THE MICROVOLUMETRIC DETERMINATION OF THE RARE EARTH ELEMENTS. Alakaeva, L. A.; Tishchenko, M. A.; Poluektov, N. S. (Inst. of General and Inorganic Chemistry, Odessa). Zh. Anal. Khim.; 26: No. 8, 1514-16(Aug 1971). (In Russian).

Conditions were found for the complexonometric determination of the rare earth elements using a terbium complex with 1,2-dihydroxybenzene-3,5-disulfonic acid as a luminescent indicator. The luminescence is excited by ultraviolet light from a mercury lamp. Li, K, Na, Cs, Be, Al, Ga, Ge, Mo, Te, UO_2^{2+} ions do not interfere in the determination of the rare earths. The standard deviation of a single determination is 0.13 to 0.22%. (auth)

57318 SPECTROPHOTOMETRIC DETERMINATION OF SMALL AMOUNTS OF SCANDIUM AND YTTRIUM IN EACH OTHERS PRESENCE. Bocharova, R. I.; Kusheleva, A. F.; Men'kov, A. A. (Second Moscow State Medical Inst.). Zh. Anal. Khim.; 26: No. 8, 1505-10(Aug 1971). (In Russian).

A method is suggested for the spectrophotometric determination of small amounts of yttrium with Arsenazo M in the presence of large amounts of scandium using NaH_2PO_4 as a masking agent. (auth)

57319 KINETIC METHOD FOR ANALYZING MIXTURES OF THE RARE EARTH ELEMENTS BASED ON THE DIFFERENCE IN THE RATES OF THE SUBSTITUTION REACTIONS IN THE COMPLEXES WITH POLYDENTATE LIGANDS. Budarin, L. I.; Yatsimirskii, K. B.; Khachatryan, A. G. (Inst. of Physical Chemistry, Kiev). Zh. Anal. Khim.; 26: No. 8, 1499-1504(Aug 1971). (In Russian).

A kinetic method for the quantitative determination of the rare earth elements was developed with the use of the parallel reactions. Two methods for the treatment of the experimental data depending on the ratios of the rate constants of the reactions are proposed. The method was applied to the quantitative determination of praseodymium and ytterbium and also lanthanum and samarium in their mixtures using the parallel reactions of replacement of Xylenol Orange by ethylenediaminetetraacetate in their intensively colored complexes with a suitable reagent. (auth)

57320 CHEMICAL ANALYSIS OF THE FUEL SOLUTION OF JRR-1. Hashitani, Hiroshi; Komori, Takuji; Yamamoto, Tadashi (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 13: No. 6, 335-8(Jun 1971). (In Japanese).

Tests were conducted on the JRR-1 in July 1960, in order to solve a number of problems essential to the operation of the reactor. The state of corrosion of the core tank wall, the behavior of the gas recombiner water, and the state of the fuel solution were examined. Additional tests were carried out in November 1967 and in January 1970. The change in volume of the fuel solution was determined by measurements of the density and the uranium concentration, and the cause of this volume change was clarified. The corrosion products and metals added to the fuel solution, i.e., iron, nickel, chromium, and copper were determined. In the second and third tests, all of the above items, as well as sulfuric acid concentration, plutonium production, and burnup were measured. All the results were compared with the values obtained at the first startup of the reactor. In the third test, a considerable amount of aluminum was found in the gas recombiner water. This element must have originated in the catalyst used in the recombiner. From the burnup determined by mass spectrometry, the cumulative power output was estimated to be nearly 22×10^4 kWh. (auth) (Japan)

57321 POLAROGRAPHIC METHOD OF DETERMINING URANIUM IN THE PRESENCE OF IRON. Tomik, B.; Matous, K. (Inst. of Mining and Metallury, Ostrava, Czech.). Hutn. Listy; 25: No. 8, 581-3(Aug 1970). (In Czech).

Polarographic reduction of uranyl ions was studied in solutions of various carbonates: sodium bicarbonate, sodium carbonate, potassium bicarbonate, potassium carbonate, sodium potassium carbonate, and ammonium carbonate. The polarographic curves differed neither in height nor in shape; slight differences were only observed between individual half-wave potential values. It is thus concluded that in all cases the same complex, $[UO_2(CO_3)_3]^{4-}$, was formed and reduced. In another experiment the reduction was performed in the presence of bicarbonate. Iron and uranium were precipitated with NaOH as $Fe(OH)_3$ and $Na_2U_2O_7$, respectively. An excess of $NaHCO_3$ was added which led to the formation of the soluble uranium complex $Na_4[UO_2(CO_3)_3]$. Polarographic reduction of this complex was studied. The method was tested on steel samples containing uranium additions. The diffusion current was practically independent of $NaHCO_3$ concentration, of pH (between pH = 7.9 and 12.3), and of iron concentration. The polarographic method yielded slightly higher results than the chemical method. Uranium concentration in the analyzed steel samples varied between 0.28 and 14.98%. For this concentration range the proposed polarographic method is quite satisfactory and yields reliable results. (NSA of Czech.)

57322 USE OF ROSS FILTERS IN RADIOISOTOPE X-RAY FLUORESCENCE DETERMINATION OF IODINE IN DRUGS. Svitel, J.; Dohnalova, E. (Komensky Univ., Bratislava). Cesk. Farm.; 19: No. 3, 89-95(Apr 1970). (In Slovak).

The use of differential Ross filters for selection of the characteristic radiation in radioisotope x-ray fluorescence analysis of drugs and chemicals containing iodine was investigated. Metal filters from rolled tin, indium, and cadmium were used. A ^{147}Pm/La bremsstrahlung source was used as the source of exciting radiation. The method was compared with the x-ray fluorescence method using pulse height selection of the characteristic radiation without a filter. The method studied was found to be less sensitive but had some other advantages (possibility of uniform calibration and elimination of the matrix effect, simplicity and low cost, and higher resolution). (NSA of Czech.)

57323 RAPID PHOTOMETRIC DETERMINATION OF SELENIUM IN TELLURIUM WITH DIFFERENT PURITY (UP TO 99.99 PERCENT). Futekov, L.; Atanasova, B. (Higher Pedagogical School, Plovdiv, Bulgaria). Natura (Plovdiv); 3: No. 1, 65-9 (1970).

Se impurities in 99 to 99.99% pure Te were determined photometrically by reducing Se(IV) in 6N HCl with Me_2CO to give a colloidal solution of Se (stabilized with gelatin), the absorbance of which was measured at 550 nm. Beer's law was followed for 50 to 500 μg Se/25 ml. The relative standard deviation was 13.63% for determining 200 μg Se in the presence of 0.6 g Te. (Selenium–Tellurium Abstr.)

57324 DETERMINATION OF SILICON IN PURE TELLURIUM. Dobrowolski, Jan; Kwiatkowska-Sienkiewicz, Krystyna (Politechnika, Danzig). Chem. Anal. (Warsaw); 15: No. 3, 647-50 (1970). (In Polish).

Silicon is determined spectrophotometrically as the molybdosilicate blue after the preliminary removal of Te with tributyl phosphate. The 0.1-g sample is dissolved in 50% HCl–50% HNO_3 (5 : 1). The solution is evaporated, and the residue is dissolved in 15 ml of 8M HCl and extracted with 30% TBP in CCl_4 (2 × 10 ml). The aqueous solution, washed with 10 ml of CCl_4, is evaporated and the residue is fused with 0.2 g of Na_2CO_3. The melt is dissolved in ≃15 ml of H_2O and, after adjusting the pH to 1.5 with N-H_2SO_4, the solution is treated with 10 ml of 5% $(NH_4)_6Mo_7O_{24} \cdot 4H_2O$ solution. After 5 min., 5 ml of 5% citric acid solution and 14.5 ml of H_2SO_4 (1 : 3) are added and the solution is extracted with butanol (2 × 10 ml). The extract is made up to 25 ml with butanol, the complex is reduced with 1 ml of 1% $SnCl_2 \cdot 2H_2O$ solution, and, after 10 min., the extinction of this solution is

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measured at 760 nm against butanol. Residual Te, present at ≈0.8 μg per ml, lowers the extinction reading by 3%, and ≈15% of the Si present is lost during this procedure. The standard deviation for samples containing 0.0228 ± 0.0070% of Si (in 99.8% pure tellurium) is 0.0019%. (Anal. Abstr.)

57325 SPECTROPHOTOMETRIC DETERMINATION OF RUTHENIUM WITH 3,4-DIAMINOBENZOIC ACID. **Ayres, Gilbert H.; Arno, James A. (Univ. of Texas, Austin). Talanta; 18: No. 4, 411-27(Apr 1971).**

Ruthenium(III) chloride and 3,4-diaminobenzoic acid, in aqueous solution at pH 4.0 to 4.5, react slowly at room temperature, but more rapidly when the mixture is heated, giving solutions that go through colour transitions from amber to purple-red; maximum absorbance of fully developed solutions occurs at 550 nm. The effects of heating temperature and time, pH, reagent concentration, and other variables were studied. The system conforms to Beer's law; optimum concentration range, for measurement in 10-mm cells, is about 0.5 to ppM of ruthenium. Interference from foreign ions, especially other platinum elements, is avoided by a distillation separation of ruthenium. The spectrophotometric mole-ratio and continuous-variation methods indicated the presence of complexes of 1:2 and 1:3 ruthenium-to-reagent stoichiometry. Elemental analysis of solid products isolated from solution confirmed the 1:2 reaction ratio. Several other o-diamines gave similar coloured solutions and reaction stoichiometry. (auth) (UK)

57326 SPECTROPHOTOMETRIC DETERMINATION OF CADMIUM IN NUCLEAR-GRADE ZIRCALOY-2 AFTER SELECTIVE EXTRACTION WITH A LIQUID ANION-EXCHANGER. **Ghersini, G.; Mariottini, S. (CISE, Milan). Talanta; 18: No. 4, 442-6 (Apr 1971).**

A method is presented for the spectrophotometric determination of cadmium in Zircaloy-2 at the tenths of ppM level. The method involves the extraction of Cd with tri-n-octylamine from 1M HCl, its separation from Fe(III) by scrubbing with tartaric acid, its recovery with 2M sulphuric acid, and the final development of the Cd-dithizonate colour. The method is simple and rapid, does not require any special instrumentation, and avoids the use of toxic reagents. Cadmium at the 0.3-ppM level was determined with standard deviation 0.054 ppM. (auth) (UK)

57327 INCREASING THE ACCURACY OF TANTALUM DETERMINATION IN ORE-DRESSING PRODUCTS BY A X-RAY-RADIOMETRIC METHOD BY MEANS OF A K-JUMP OF ABSORPTION. **Abdulin, S. F. (Krasnoyarsk Inst. of Nonferrous Metals, USSR). Zh. Anal. Khim.; 26: No. 9, 1825-8(Sep 1971). (In Russian).**

A method is suggested for eliminating the filler effect during analysis by means of a K-jump of absorption. The method was used in the x-ray-radiometric analysis of ore-dressing products for tantalum. (auth)

57328 CONDITIONS FOR THE LUMINESCENCE DETERMINATION OF URANIUM IN SILICON DIOXIDE OF HIGH PURITY. **Dobrolyubskaya, T. S. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim.; 26: No. 9, 1835-6(Sep 1971). (In Russian).**

Optimum conditions for the luminescence determination of uranium as an impurity in silicon dioxide of special purity with a sensitivity of ~3×10^{-6}% were established. (auth)

57329 DETERMINATION OF THE OXYGEN CONTENT IN METALLIC RUTHENIUM. **Karlenko, G. S.; Burtsev, V. T.; Smirnov, Yu. A.; Polonskii-Bulaev, A. A. (Inst. of Metallurgy, Moscow). Zh. Anal. Khim.; 26: No. 9, 1843-5(Sep 1971). (In Russian).**

The content of oxygen in ruthenium was determined by the vacuum-fusion method by means of an auxiliary nickel–iron–carbon melt at a temperature of 1650°C and an extraction time of 7 min. The analysis was carried out with additives of tin at a dilution of 1:10. (auth)

57330 ELIMINATION OF THE EFFECT OF THE SAMPLE COMPOSITION ON THE LINE INTENSITY OF CERTAIN RARE METAL IMPURITIES. **Pometun, E. A.; Romaikina, E. P.; Korsun, V. I.; Gazieva, M. T.; Khaimova, Sh. M. (Tadzhik State Univ., Stalinabad, USSR). Zh. Anal. Khim.; 26: No. 9, 1706-9 (Sep 1971). (In Russian).**

The possibility of eliminating the effect of the composition of analyzed powders on the results of the spectrographic determination of niobium, tantalum, zirconium, and hafnium by treating the samples with H_2F_2 and chlorination in a chamber electrode is discussed. The possibility of chlorinating complex compounds of these metals that form in a H_2F_2 medium was proved by thermodynamic calculations taking as an example potassium fluoro- and oxyfluoroniobates. (auth)

57331 CONDITIONS FOR CERIUM SORPTION BY CHROMATOGRAPHIC PAPER MODIFIED WITH CARBOXYLIC ACIDS FOR ITS DETERMINATION BY THE PEROXIDE METHOD. **Ganopol'skii, V. I.; Krivonozhnikova, L. G.; Ermolenko, I. N. (Inst. of General and Inorganic Chemistry, Minsk). Zh. Anal. Khim.; 26: No. 9, 1757-63(Sep 1971). (In Russian).**

Conditions were studied for cerium sorption by chromatographic paper modified with citric acid. Sorption under static and dynamic conditions was examined. The best variant is cerium sorption by passing the solution through the paper sample at a rate of 2 ml/min. The optimum volume of the test solution is 100 ml. The concentration of the element in the solution is directly proportional to the amount of cerium sorbed by the paper, just as the cerium content in the sample is directly proportional to the intensity of the reflected radiation. The sensitivity is down to 10^{-8} mole of cerium or 1.7 μg of CeO_2. The mean square error of cerium determination in the range 0.3×10^{-7} to 1×10^{-7} mole is 5.4% relative. (auth)

57332 DETERMINATION OF EUROPIUM, TERBIUM, SAMARIUM, AND DYSPROSIUM IN OPTICAL FLUORITE. **Galkina, L. L.; Strel'tsova, S. A. (Central Asian Scientific-Research Inst. of Geology and Mineral Resources, Tashkent). Zh. Anal. Khim.; 26: No. 9, 1764-6(Sep 1971). (In Russian).**

A method was developed for isolating very small amounts of the rare earth elements from fluorite by extraction with butyric acid. Separate rare earths are then determined by spectrographic and fluorimetric methods. By means of the fluorimetric method it is possible to determine down to 5×10^{-7}% Eu_2O_3, 5×10^{-5}% Sm_2O_3, $n \times 10^{-6}$% Tb_4O_7, and $n \times 10^{-5}$% Dy_2O_3 in fluorite. (auth)

57333 REZARSON AS A REAGENT FOR THE SPECTROPHOTOMETRIC DETERMINATION OF NIOBIUM. **Lukin, A. M.; Kaslina, N. A.; Petrova, G. S. (All-Union Scientific Research Inst. of Chemical Reagents and Specially Pure Chemicals, Moscow). Zh. Anal. Khim.; 26: No. 9, 1782-5(Sep 1971). (In Russian).**

2,2′,4′-Trihydroxy-3-arsono-5-chloroazobenzene (rezarson) was studied as a reagent for the spectrophotometric determination of niobium. A 50% water–ethanol medium 1 N with respect to HCl is most suitable for determination of niobium. The stoichiometric ratio of the components is $[R]:[Nb] = 1:1$. The molar extinction coefficient of the reagent is 1.6×10^3, that of the complex is 1.94×10^4, the equilibrium constant is 6.5×10^5. A method was developed for determining niobium in ores. (auth)

57334 POLAROGRAPHIC DETERMINATION OF URANIUM IN MONAZITE SANDS. **Martres, R. W.; Burastero, J. J. (Centro de Investigaciones Tecnologicas, Pando, Uruguay). Analyst, 96: No. 1145, 579 83(Aug 1971).**

The extraction of uranium from monazite sands and its subsequent polarographic determination are described. The sample is decomposed by fusion with potassium hydrogen difluoride followed by fusion with potassium pyrosulphate. Uranium is extracted from nitric acid solution with tributyl phosphate in 2,2,4-trimethylpentane, with aluminum nitrate as a salting-out agent, and back-extracted from the organic phase with water. The final polarographic determination is carried out in 2 M acetic acid–2M ammonium acetate–0.1 M ascorbic acid solution as supporting electrolyte. Neither a maximum suppressor nor removal of oxygen is needed. The interference by lead and some factors influencing the extraction of uranium are studied. The results are reproducible and agree with those obtained by other, more laborious, techniques. The proposed procedure is suitable for the determination of uranium in monazites and monazite sand concentrates containing not less than 0.005% of uranium oxide, and is superior in speed, reliability, and convenience to other methods previously reported. (auth)

57335 INFLUENCE OF VARIOUS CARRIERS IN THE SPECTROGRAPHIC ANALYSIS OF OXIDES OF REFRACTORY METALS (TUNGSTEN AND ZIRCONIUM). **Pevtsov, G. A.; Raginskaya, L. K.; Manova, T. G.; Sotnikova, V. S. Tr. Vses. Nauch.-Issled. Inst. Khim. Reaktivov; No. 31, 150-7(1969). (In Russian).**

In an attempt to improve the sensitivity of the direct spectrographic determination of Cr, Co, Cu, Ni, V, Fe, and Mn in tungsten trioxide and zirconium dioxide, a study was made of the effects on the line intensities of additions of certain halides. The zirconium dioxide sample is mixed with AgCl and NaCl, and the spectrum is excited in a 12-A dc arc. The tungsten trioxide procedure is similar, but powdered carbon is added, and the carrier is KI–NaF (4:1). The sensitivity is 1 ppM for Cr, Co, Fe, Ni, or V, and 0.5 ppM for Cu or Mn. (Referativnyi Zh.)

57336 HIGHLY SENSITIVE METHODS FOR DETERMINING TRACES OF MOLYBDENUM AND OTHER ELEMENTS, BASED

ON AMPEROMETRY, COLORIMETRY, AND PHOTOMETRY. IV. KINETIC BIAMPEROMETRIC DETERMINATION OF NANOGRAM AMOUNTS OF MOLYBDENUM. Shafran, I. G.; Rozenblyum, V. P.; Shteinberg, G. A. Tr. Vses. Nauch.-Issled. Inst. Khim. Reaktivov; No. 31, 171-82(1969). (In Russian).

The method is based on the catalytic action of Mo on the oxidation of KI by H_2O_2. Vibrating Pt electrodes are placed in an amperometric cell containing the test sample to which H_2SO_4 and KI have been added. One minute after an addition of 0.0125M H_2O_2, the current–time curve is recorded for 5 to 7 min. The content of Mo is found from the slope of the resulting graph along with a calibration graph. The effects of a number of other elements were studied. The literature on the determination of traces of Mo, the forms in which Mo may be present in solution, and kinetic amperometric and biamperometric methods of analysis is reviewed. (87 references.) (TSS)

57337 FUNDAMENTAL STUDY ON THE COLLECTION OF URANIUM IN SEAWATER. Ogata, Noboru (Japan Monopoly Corp., Tokyo). Nippon Kaisui Gakkaishi; 24: No. 5, 197-212 (Feb 1971). (In Japanese).

Through the course of a fundamental study on the collection of uranium in seawater, an extensive improvement was made in the separating and determining methods of uranium. Various studies were made on the collecting methods of uranium in seawater, the adsorption method with titanic acid being the most effective. Chemical species of uranium in seawater were researched by the stability constants of such components as Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, SO_4^{2-}, F^-, PO_3^{3-}, HPO_3^{2-}, CO_3^{2-}, OH^-, and UO_2^{2+}. As consequence, most of the dissolved uranium species were found to be $UO_2(CO_3)_3^{4-}$. The adsorption mechanism of uranyl carbonate complex ion on titanic acid was presumed an anion exchange reaction. The adsorption of uranium was governed by the kind of titanic acid, the temperature of seawater, the contacted volume of seawater, and the concentration of uranium in seawater. (auth) (Japan)

57338 DETERMINATION OF CERIUM IN REFRACTORY ALLOYS WITH USE OF CHROMATOGRAPHIC SEPARATION. Fokina, L. S.; Fedorova, N. D.; Kurbatova, V. I.; Nikulina, I. N.; Zhilkina, S. P. Tr. Vses. Nauch.-Issled. Inst. Stand. Obraztsov Spektr. Etalonov; 5: 118-22(1969). (In Russian).

The method is based on removal of Ti, Fe, Cu, and (in part) Zr from a HCl solution of the sample by ion exchange, followed by concentration and separation of Ce from Ni, Al and Mn by ion exchange in HNO_3–acetic acid medium. The Ce is determined photometrically. A detailed procedure is given. (TSS)

57339 USE OF ION-EXCHANGE CHROMATOGRAPHY IN DETERMINATION OF VANADIUM IN FERROVANADIUM AND IRON ORE. Studenskaya, L. S.; Stepin, V. V.; Vorozhbitskaya, K. F. Tr. Vses. Nauch.-Issled. Inst. Stand. Obraztsov Spektr. Etalonov; 5: 83-91(1969). (In Russian).

Aqueous solutions of ferrovanadium or iron ore samples are prepared and the acidity adjusted. The solution is passed through a column of cationite KU-2, previously washed with 0.5N H_2SO_4 containing 1% H_2O_2. This acid solution is used for washing the column to remove all of the V. Fe, Al, and Mn remain on the column. The washings are evaporated then titrated with an Fe(II) salt solution with a potentiometric indication of the end-point. The method has also been used for the analysis of titanomagnetite. (TSS)

57340 SPECTROPHOTOMETRIC DETERMINATION OF TRACES OF SILICON AS MOLYBDENUM BLUE IN URANIUM DIOXIDE. Rajkovic, D. (Inst. for Tech. of Nuclear Raw Materials, Belgrade). Z. Anal. Chem.; 255: No. 3, 190-4(1971).

A procedure for the determination of small amounts of silicon in uranium dioxide is described. Silicon is determined directly in the sample solution by means of the molybdenum blue method with 1-amino-2-naphthol-4-sulfonic acid as a reducing agent. Contents down to 5 ppM can be determined with an error not exceeding ±5%. (auth)

57341 SUCCESSIVE DETERMINATION OF URANIUM AND THORIUM IN OXIDES OF THE RARE EARTH ELEMENTS. Rusakova, V. P.; Solonovich, V. F.; Kalmykova, I. S. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 153-4(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 153-4(Jan-Feb 1971).

The joint extraction of microgram quantities of uranium and thorium with the aid of TBP was studied for analytical applications. An extraction method was proposed for the successive separation of uranium, thorium, and rare earth elements. Successive photometric determination of uranium and thorium in amounts of 0.01 to 0.001% in oxides of the rare earth elements is proposed. (auth)

57342 PHOTOMETRIC METHOD FOR THE DETERMINATION OF ULTRAMICROQUANTITIES OF THORIUM IN ROCKS. Gumbar, K. K.; Bozhichko, M. A. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 155-7(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 155-7(Jan-Feb 1971).

A photometric method was developed for the determination of ultramicroquantities of thorium in rocks of various compositions. The conditions of chromatographic separation of thorium from the rare earth elements, U, Zr, Sc, and other elements on the anion exchange resin Dowex 1X10 in nitric acid medium were investigated. (auth)

57343 POSSIBILITIES OF SPECTROPHOTOMETRIC DETERMINATION OF URANIUM IN WASHING, PROCESSING, AND WASTE WATERS FROM NUCLEAR POWER PLANTS. Parimucha, F.; Rostek, J. (Atomova Elektraren, Jaslovske Bohunice, Czech). Radioisotopy; 11: No. 5, 865-72(1970). (In Czech).

Spectrophotometric uranium determination in washing, processing, and waste waters by means of Chromazurol S in the presence of gelatin as detergent is described. Uranium is determined at $\lambda = 590$ nm and pH = 3.0 ± 0.1. The determination sensitivity is reduced in comparison with other methods but by concentration of uranium on the annex Amberlite 402 in the SO_4^{2-} cycle, the decreased sensitivity is compensated. (auth)

Isotope Dilution Procedures

Refer also to abstract 57924.

Radiometric and Radiochemical Procedures

Refer also to abstracts 57505, 57752, and 57998.

57344 (CEA-R-4218) TECHNIQUES OF CONTINUOUS MEASUREMENT OF RADIOACTIVE FISSION GASES EVOLVED IN FUEL ELEMENTS. Chenebault, Pierre; Hairion, Jean-Pierre; Kurka, Gerard (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jul 1971. 17p. (In French). Dep. NTIS (U. S. Sales Only).

The sampling circuits installed at the CEN–Grenoble allow radioactive rare gases, with half-lives greater than or equal to three minutes, released from nuclear fuel elements, to be analyzed. The separation of xenon from krypton by gas chromatography led to an enhancement in the quality of the gamma spectra obtained using Li-doped Ge detectors. (France)

57345 (CONF-711002–, pp 293-306) ASSAY OF SAMPLES FOR NUCLEAR MEASUREMENTS BY COUNTING AND CHEMICAL ANALYSIS. Lauer, K. F. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

The nondestructive and destructive methods of analysis used in the fabrication of targets to be used for quantitative cross-section measurements are described. The experience and problems at the Central Bureau for Nuclear Measurement with isotopes of the actinide elements and rare earth samples are reviewed. (D.H.M.)

57346 (IFA-FR-82) DETERMINATION OF THE CONCENTRATION OF ^{59}Fe IN THE COOLANT WATER OF VVR-S REACTOR. Ionescu, E.; Ionescu, G.; Alexan, Z. (Institutul de Fizica Atomica, Bucharest (Romania)). 1971. 11p. Dep. NTIS (U. S. Sales Only).

The concentration of ^{59}Fe in the coolant water of a VVR-S type reactor can be determined by two methods: scintillation gamma spectrometry and polarography. To separate the energy lines of ^{60}Co and ^{59}Fe in the coolant water samples from the primary circuit, which have very close concentrations, the activities were measured two times; at the first determination the sum concentration corresponding to ^{60}Co and ^{59}Fe was measured and after a time interval sufficiently long to allow the disintegration of ^{59}Fe, the activity corresponding to ^{60}Co only was determined. Subtracting the values of ^{60}Co activities corrected for time, values for the ^{59}Fe activities and concentrations were obtained. The results obtained by scintillation spectrometry are highly consistent with those determined by the polarographical method. (auth)

57347 (RT/PROT-(71)9) RADIOTOXICOLOGICAL ANALYSES USED AT CNEN. Testa, C.; Masi, G.; Bazzarri, S.; Marchionni, V.; Santori, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 14 Apr 1971. 110p. (In Italian). Dep. NTIS (U. S. Sales Only).

Methods of radiotoxicological analyses in use at CNEN are described. A short introduction reports the sampling of biological samples, the sampling intervals, and the reference levels. The different techniques for the determination of α, β, and γ emitters in biological samples are then described, i.e., the determination of ^{210}Po, ^{226}Ra, natural thorium, natural uranium, enriched uranium, plutonium, gross alpha activity, tritium, ^{90}Sr, gross beta activity, gamma emitters, and of creatinine in urine; the analyses of α, β, and γ emitters in nose blow and feces samples are finally reported. Some schedules are presented for the registration of the values obtained. (auth)

57348 (TID-25777) 1971 RESULTS FOR THE INTERCOMPARISON OF ANALYTICAL METHODS FOR ^{137}Cs AND ^{134}Cs USED AT SCRIPPS WITH METHODS USED AT 56 OTHER INSTITUTIONS. Hodge, V. F.; Folsom, T. R.; Hansen, N. (Scripps Institution of Oceanography, La Jolla, Calif.). 16 Mar 1971. Contract AT(04-3)-34. 9p. Dep. NTIS.

The method used at Scripps for determining the ^{137}Cs and ^{134}Cs in seawater is described. The cesium was precipitated by ammonium 12-molybdophosphate (AMP) and dried for γ counting; the supernatants were then scavenged with ferric hydroxide, precipitated a second time by AMP, and dried for γ counting. All AMP and ferric hydroxide precipitates were counted above a 5′ × 4′ sodium iodide scintillator crystal, using a conventional 200-channel analyzer. Since the samples were mixtures of ^{137}Cs and ^{134}Cs, the 0.605-MeV peak of ^{134}Cs partially overlapped the FWHM area of ^{137}Cs. Therefore, the first AMP precipitates were counted again with a two-dimensional sodium iodide spectrometer. The results obtained showed good agreement with those from Battelle Northwest Laboratory. (D.H.M.)

57349 MICROANALYTICAL DETERMINATION OF CARBON AND HYDROGEN, ^{14}C, TRITIUM AND DEUTERIUM IN A STREAM OF NITROGEN. Frohofer, H. (Univ., Zurich). Z. Anal. Chem.; 253: No. 2, 97-102(1971). (In German).

A microanalytical method for the determination of carbon and hydrogen is described. The procedure involves the combustion of the organic substance in a stream of nitrogen and the oxidation of the decomposition products with oxygen. Halogens and sulphur are absorbed by the combustion catalyst (according to Körbl), whereas nitrogen oxides are reduced on a copper surface. The combustion products, CO_2 and H_2O, are determined gravimetrically; in the case of radioactive samples they are appropriately absorbed and counted in a liquid scintillation counter. Strongly quenching singly and doubly labeled samples, which cannot be accurately counted even by modification of the counting device, give equally high radioactive yields (75% for ^{14}C, 30% for ^{3}H), since counting is not influenced by other gaseous impurities. Deuterium is quantitatively determined by measuring the intensity of the OD-signal at 2500 cm^{-1} with an infrared spectrometer. (auth)

57350 ANALYSIS OF RADIOPHARMACEUTICALS. Jaffee, Max; Ford, Leonard (Food and Drug Administration, Washington, D. C.). J. Ass. Offic. Anal. Chem.; 54: No. 4, 879-83(Jul 1971).

Some of the activities of chemists engaged in evaluating and selecting analytical methodology for examination of radiopharmaceuticals and the criteria for assessment of their quality are described. Significant problems, as they relate to a regulatory analysis program, and tentative solutions to these problems are discussed. Conclusions and recommendations, based on the results of analysis of selected radiopharmaceutical preparations of commercial origin, are given. (auth)

57351 EVALUATION OF ION-EXCHANGE SURVEILLANCE SAMPLER FOR ANALYZING RADIOACTIVE LIQUID EFFLUENTS. Krieger, H. L.; Frishkorn, G. W. (Bureau of Radiological Health, Cincinnati). Health Phys.; 21: No. 4, 591-5(Oct 1971).

Data are presented for ^{58}Co, ^{60}Co, ^{89}Sr, ^{90}Sr, ^{131}I, ^{134}Cs, ^{137}Cs, and ^{140}Ba$-^{140}$La at 10^{-1} pCi/levels in reactor effluent water at the point of release. Analysis of these nuclides in environmental media provides needed information with respect to their critical pathways and the calculation of radiation exposure to the population. The low levels of radionuclides in aqueous media can be determined by processing large sample volumes through a multisection column of cation- and anion-exchange resins. The column concentrates these radionuclides from 200 l of water having as much as 250 ppM hardness, or from larger volumes of softer water. The column dimensions were designed on the basis of tracer studies with ^{137}Cs, ^{85}Sr, ^{60}Co, and ^{131}I to assure almost complete retention of these nuclides in the uppermost section of the cation- or anion-exchange resins. The nuclides that emit γ rays are identified by spectrometer, and all radionuclides are determined radiochemically after eluting them from the sections with 6 N HCl. (auth)

57352 NEW METHOD FOR THE SEPARATION OF MULTICURIE QUANTITIES OF ^{90}Y FROM ^{90}Sr. Kanapilly, G. M.; Newton, G. J. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Contract AT(29-2)-1013. Int. J. Appl. Radiat. Isotop.; 22: No. 9, 567-75(Sep 1971).

A simple, economical method for the separation of ^{90}Y from ^{90}Sr$-^{90}$Y was developed. The technique consisted of forming colloidal yttrium hydrogen phosphate under precisely controlled conditions and separating the ^{90}Y from ^{90}Sr by filtration. This method was used to prepare several multicurie samples of ^{90}Y with specific activities of 5×10^4 Ci/g. Recoveries of ^{90}Y at nearly 100% with ^{90}Sr contamination of less than 1×10^{-6}% of that of ^{90}Y were routinely achieved. The basic technique with appropriate changes was adapted for the rapid assaying of ^{90}Sr contamination in the ^{90}Y sample and for the preparation of ^{140}La from ^{140}La$-^{140}$Ba. (auth)

57353 PRACTICAL METHOD FOR RESOLUTION OF TWO β-EMITTING RADIONUCLIDES BY LIQUID SCINTILLATION COUNTING. Snipes, M. B.; Lengemann, F. W. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-4039. Int. J. Appl. Radiat. Isotop.; No. 9, 513-20(Sep 1971).

A practical method for resolution of mixtures of two β-emitting radionuclides is described utilizing liquid scintillation counting procedures that combine simplicity of quench correction with the reliability of the discriminator ratio method of double-label counting. A channel is set for each radionuclide, allowing 10% overlap of the lower energy member into the channel set for the higher energy member, and quench correction standards and experimental samples are counted with and without an external standard. Simultaneous equation solutions are used, which make optimal use of channels ratio data available by direct print-out. If R_A and R_B equal net cpm in channels A and B, R_a and R_b equal net cpm for radionuclides a and b, and F_a^{-1} and F_b equal the channels ratio A/B for radionuclides a and b, then $R_a = (F_b R_B - R_A)/(F_a F_b - 1)$ and $R_b = (F_a R_A - R_B)/(F_a F_b - 1)$. Values for F and counting efficiency (to convert cpm to dpm), as functions of the channels ratio A/B for the external standard, may be graphically derived from the quench correction graph made using counting data for the appropriate quench correction standards. Absence of restrictions and ease of adaptation make the method applicable to any pair of β-emitting radionuclides sufficiently different in energy to be accurately resolved; this can be determined from a plot of percent error in resolution of each radionuclide as a function of the ratio of the amounts of each member present in the mixture. (auth)

57354 DETERMINING THE CONTENT OF CHEMICAL ELEMENTS OR ISOTOPES THEREOF IN A SPECIMEN BY UTILIZING THE EFFECT OF RECOILLESS RESONANCE ABSORPTION OR SCATTERING OF GAMMA RAYS. Dolenko, Anatoly Vasilievich; Egiazarov, Boris Grigorievich; Isakov, Lev Mikhailovish; (and others). U. S. Patent 3,597,615. 3 Aug 1971. Filed 28 Feb 1967.

An arrangement and process for determining the content of chemical elements, isotopes, or compounds in a specimen are presented. Measurements are made during irradiation of the specimen with gamma rays of a quantity that is proportional to the content of the element, isotope, or compound in the specimen. (auth)

57355 METHODS OF DETERMINATION OF ^{137}Cs IN OBJECTS OF THE EXTERNAL ENVIRONMENT. Shvydko, N. S.; Popov, D. K.; Borichev, A. A.; Mikhailova, O. A. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 97-102(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 102-7(Jan-Feb 1971).

A survey of the methods of determination of ^{137}Cs in objects of the external environment is cited. A method is suggested for the determination of ^{137}Cs, providing for a combination of potassium-cobalt ferrocyanide concentration of the cesium with γ spectrometry or a measurement of the β activity of the adsorbent. (auth)

57356 DETERMINATION OF COBALT IN NICKEL PREPARATIONS BY A RADIOCHEMICAL METHOD. Shamaev, V. I.; Garbauskas, G. K.; Martynov, A. M. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 88-91(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 94-7(Jan-Feb 1971).

The possibility of direct determination of Co in nickel preparations with a substoichiometric amount of 1-nitroso-2-naphthol by the method of radiometric correction was studied. The possibility of determining Co in the presence of a large (up to 100-fold) excess of Ni with preliminary isolation of Co by the nitrite method, followed by determination with a substoichiometric amount of 1-nitroso-2-naphthol, was studied. A simple, rapid, and sufficiently accurate radiometric method was developed for the determination of Co in Ni with the aid of a calibration curve. (auth)

57357 STUDY OF THE BEHAVIOR OF VARIOUS VALENCE FORMS OF PLUTONIUM IN THE ACID–TBP SYSTEM BY THE METHOD OF THIN-LAYER CHROMATOGRAPHY ON SILICA GEL. **Volynets, M. P.; Milyukova, M. S. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 67-72(Jan-Feb 1971).**

Translated from Radiokhimiya; 13: No. 1, 72-8(Jan-Feb 1971).

The distribution of different valence forms of plutonium in systems of acid–TBP was studied by the method of thin-layer chromatography on silica gel. It was established that Pu(IV) and Pu(VI) are quantitatively concentrated at the line of the solvent front when they are sorbed for 3 to 5 N HNO_3. A quantitative separation of Pu(IV) and Pu(VI) from Pu(III) is possible in the system 3N HNO_3–23% solution of TBP in synthine. The method of thin-layer chromatography permits an easy and comparatively rapid detection of the disproportionation of tetravalent plutonium in nitric acid and perchloric acid solutions. In the case of a single chromatography on a layer of silica gel impregnated with 3N HNO_3 (on one part of the plate), as well as 1N $HClO_4$ (on the adjoining section), using a 23% solution of TBP in synthine as the mobile solvent, plutonium can be quantitatively separated from U, Zr, Ni, Pb, Cu, Cr, and Fe, and the rare earth elements, and it can be determined radiometrically in the zone on the plate with an accuracy of ±10 to 15%. The time of analysis was 60 to 90 min. The volume of the solution to be analyzed was 0.03 ml. (auth)

57358 PREPARATION OF GAS SAMPLES FROM CARBONATES AND THEIR SOLUTIONS FOR THE MEASUREMENTS OF THE ACTIVITY OF ^{14}C. **Zhukovskaya, L. P.; Karavaev, F. M.; Sokolova, I. A. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 165-6(Jan-Feb 1971).**

Translated from Radiokhimiya; 13: No. 1, 163-4(Jan-Feb 1971).

The ^{14}C in the salt sample or solution is completely converted to CO_2, which is introduced, in exactly known amounts, to proportional counters. The error in measurement using this method is 1.5 to 2%. (M.C.G.)

57359 ANALYSIS OF CONTAMINATIONS IN BIOLOGICAL SAMPLES BY HEAVY ION SCATTERING. **Seaman, G. G.; West, J. K. (Kansas State Univ., Manhattan). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 87-90(Feb 1971).**

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

In the elastic scattering of a moving ion by a stationary target nucleus, the maximum scattering angle in the laboratory reference frame is equal to, or less than, 90° if the mass of the scattering nucleus is equal to, or less than, that of the incident ion. Thus, beams of oxygen ions incident upon a biological sample composed of only carbon, hydrogen, and oxygen will not scatter into a detector placed at an angle greater than 90°. Any element heavier than oxygen scatters incident oxygen ions into such a detector. This particular choice of incident ion and detector position discriminates against the bulk of the material in a biological sample and allows detection of only the minor constituents. Accelerated beams of 20- to 30-MeV oxygen ions from the Kansas State University tandem Van de Graaff accelerator were used in this technique. Initial studies have centered upon determining the contaminations that are present in flour. Thick targets are used, so that the beam is stopped entirely within the sample. The spectrum consists of a continuous distribution of energies up to a maximum energy, corresponding to ions scattering from the surface of the sample. This maximum energy determines the mass of the contaminant nuclei, while the number of scattered particles is proportional to the quantity of contaminant nuclei. (auth)

57360 DETERMINATION OF TRACE ELEMENTS IN SAMPLES BY NUCLEAR SCATTERING AND REACTION TECHNIQUES. **Jolly, R. K.; Gruhn, C. R.; Maggiore, C. (Michigan State Univ., East Lansing). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 91-5(Feb 1971).**

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The feasibility of using low-energy (15- to 25-MeV) α-particle scattering for detecting traces of heavy elements in a bulk of light elements, as, for example, in biological and environmental matter, is explored. These measurements can provide information on all the elements in the same simultaneously. Heavy elements require good energy resolution (~10 keV) for definite identification while light elements can be identified even with very poor energy resolution ($\geq$100 keV). Results of some measurements on a fish sample are presented. Similarly, sub-Coulomb (p, α) reactions are explored for measuring traces of very light elements in a bulk of heavy elements. Suitable choice of bombarding energy almost completely suppresses the contribution from the heavy element. Results of a measurement in a very pure Zr sample are presented. (auth)

57361 LIQUID SCINTILLATION COUNTING OF ^{45}Ca IN SOFT TISSUES. **Patrick, G.; Stirling, C. (Medical Research Council, Harwell, Eng.). Int. J. Appl. Radiat. Isotop.; 22: No. 10, 627-9(Oct 1971).**

A method was developed for counting ^{45}Ca in soft tissue, such as rat small intestine, at high efficiency with short preparation time. The calcium was present as a calcium oxalate precipitate. By carrying out the whole process of sample preparation of the oxalate in the counting vial the main difficulties associated with counting the soluble calcium salts were overcome. The counting efficiency was 87% with 5 mg calcium. The amount of calcium precipitated in the vial affected the counting efficiency and reproducibility very little up to 60 mg Ca but above this the efficiency was markedly reduced. For most purposes envisaged it was shown that no quench correction was required. (UK)

57362 UNFOLDING OF EXPERIMENTAL ALPHA-PARTICLE SPECTRA FOR DETERMINATION OF THE SPECIFIC ACTIVITY OF ALPHA-EMITTING NUCLIDES IN BIOASSAYS IN THE MILLIGRAM RANGE. **May, H. P. (Gesellschaft fuer Strahlenforschung mbH, Frankfurt am Main). pp 665-85 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).**

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The decay energy and the specific activity must be known in order to estimate the absorbed energy. In the case of alpha-particle-emitting nuclides both can be simultaneously determined for bioassays in the milligram range by alpha-particle spectrometry. A mathematical evaluation method for determination of the specific activity, based on the approximate unfolding of alpha-particle spectra detected by a plane parallel, gridded ionization chamber and stored by a multichannel pulse-height analyzer is outlined. The radionuclides used were ^{241}Am and ^{232}Th with its decay products. (auth)

57363 COUNTING TRITIATED WATER. **Francois, B.; Limandas, M. (Hopital de l'Antiquaille, Lyon). Int. J. Appl. Radiat. Isotop.; 22: No. 10, 632-3(Oct 1971).**

A comparative assay was made of five commonly used scintillating media for counting tritiated water in aqueous solutions; Bray solution, toluene–triton, Ne 240^R and Ne 250^R (Nuclear Enterprises, Ltd.) and Instagel^R (Packard Instrument Company, Inc.). Results obtained using three different figures of merit are tabulated. It was concluded that for medical use 10 ml Instagel plus 4 ml aqueous sample is a combination to be strongly recommended on the basis of efficiency, volume of aqueous sample incorporated, and saving of scintillating solution. (UK)

57364 ^{14}C IN ATMOSPHERE AND BIOSPHERE. **Chudy, M.; Povinec, P.; Seliga, M.; Saro, S. (Katedra Jadrovej Fyziky Prirodovedeckej Fakulty UK, Bratislava). Radioisotopy; 11: No. 5, 935-51(1970). (In Czech).**

The determination of ^{14}C in atmospheric carbon dioxide and biological samples is described. The activity of the samples is measured using a gas-filled proportional counter. The working characteristics of the counter and possibilities of its use in low ^{14}C activity measurements were studied. The influence of conditions during measurement on results is discussed and some corrections are presented. The results of measurements of relative ^{14}C excess in atmosphere and biosphere over the natural levels are presented. (auth)

57365 ^{226}Ra ACTIVITY DETERMINATION IN NON-EQUILIBRIUM STATE BY SCINTILLATION GAMMA SPECTROMETRY. **Lenger, V.; Thomas, J. (Ustav Hygieny Zareni, Prague). Radioisotopy; 11: No. 5, 797-811(1970). (In Czech).**

A gamma spectrometric method of activity determination in nonequilibrium state was elaborated, based on the utilization of the time course of ^{214}Pb and ^{214}Bi activities during return to equilibrium in a hermetically sealed ^{226}Ra reference source. The principle of the method can be generalized to the complete analysis of the Ra, ^{214}Pb, and ^{214}Bi mixture in an arbitrary grade of equilibrium. (auth)

57366 DOSIMETRIC CHECKING OF ^{90}Sr IN THE BIOLOGICAL CHAIN. **Benes, J.; Tomasek, M. (Radiologicka Dozimetrie UJV CSAV, Prague). Radioisotopy; 11: No. 5, 823-34(1970). (In Czech).**

A procedure for isolation of radiostrontium from natural samples based on the precipitation of insoluble sulfates and chromates from EDTA medium is proposed. This procedure is suitable for dosimetric determination of ^{90}Sr in chemically complex systems. (auth)

57367 SEPARATION OF RADIOIODIDE FROM SIMULATED BIOLOGICAL SAMPLES BY ISOTOPIC EXCHANGE IN A HET-

XUM

EROGENEOUS SYSTEM. Stollarova, N.; Zaduban, M. (Prirodovedecka Fakulta UPJS, Kosice, Czech.). Radioisotopy; 11: No. 5, 851-64(1970). (In Czech).

Possibilities of the determination of radioiodide by isotopic exchange in a medium of inorganic ions, amino acids, proteins, and in animal organs are described. The possibility of application of isotopic exchange to the measurement of radioiodide from aqueous solutions using liquid scintillators based on toluene was also investigated. (auth)

Activation Procedures

Refer also to abstracts 57796 and 57805.

57368 (AED-C-14-5) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. Section 14: Activation Analysis. Bock-Werthmann, W.; Niebuhr, H.; Sansoni, B. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). May 1971. 276p. (In English and German). Dep. NTIS (U. S. Sales Only).

57369 (RFT-Trans-83) RAPID DETERMINATION OF BORON IN GLASS BY PROMPT γ-RAY MEASUREMENT. Kusaka, Y.; Tsuji, H.; Egawa, M. Translated for Dow Chemical Co., Rocky Flats Div., from Nippon Kagaku Zasshi; 88: No. 9, 1006-8(1967). 8p. Dep. NTIS.

Nondestructive determination of boron in glass samples by using an americium–beryllium neutron source (300 mCi) and by measuring the 0.478-MeV prompt γ ray produced in the $^{10}B(n,\alpha)^{7}Li$ reaction is described. An appropriate arrangement of the neutron source, a paraffin block as a neutron moderator, a lead block as a radiation shield, a lithium fluoride plate as a neutron shield, a sample container, and a prompt γ detector are proposed. The detector was a NaI scintillator (1.5″ × 1″) connected to a 400 channel pulse height analyzer. This method is applicable for the glass with relatively low boron content (0.5 to 6.0% as B_2O_3). The analytical error was 2 to 4%, and it takes only 15 min for one run. (auth)

57370 RADIOACTIVATION DETERMINATION OF Se, Te, AND Au IN NATURAL WATERS. Abdullaev, A. A.; Sharipov, E. B.; Khudaibergenov, U.; Khasanov, A. S. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 71-2(1971). (In Russian).

A radioactivation method was developed for simultaneously determining Se, Te, and Au in waters. The dried residues are irradiated, and combined with milligram quantities of inactive Se, Te, and Au as carriers. The subsequent extraction procedure is given in detail. Assay for the desired elements is made on a γ spectrometer using a NaI(Te) crystal. The sensitivity of the method is claimed to be 10^{-10} g/ml of Se or Au, and 10^{-9} g/ml of Te for an 8- to 10-hour exposure in the reactor. (K.S.W.).

57371 DETERMINATION OF TANTALUM IN SPHERE BY ACTIVATION ANALYSIS. Babaev, A.; Khaidarov, A.; Akramov, M. B.; Dusmatov, V. D. (Physical-Technical Inst., Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 14: No. 6, 22-5(1971). (In Russian).

In the search for an economical analytical method for Ta in sphene, samples of the latter were subjected to a neutron flux density of 1.8×10^{13} n/cm^2·sec for 5 hr and then "cooled" for 15 days to permit short-lived radioisotopes to decay. A γ spectrometer was used to obtain the gamma spectra of the standard and an unknown sample. The photopeak of ^{182}Ta (0.068 MeV), together with its half-life (111 days), leave little room for interference from the other naturally occurring components of sphene. (K.S.W.).

57372 EMISSION-SPECTRAL AND RADIOACTIVATION ANALYSIS OF YTTRIUM OXIDE WITH PRELIMINARY CONCENTRATION OF RARE EARTH IMPURITIES BY EXTRACTION CHROMATOGRAPHY. Zemskova, M. G.; Lebedev, N. A.; Melamed, Sh. G.; (and others). Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 22: 116-20(1968). (In Russian).

A method of chemico-spectral analysis was developed for yttrium in a mixture of rare earths from lanthanum to holmium which surpasses the method of direct spectral analysis in sensitivity by a factor of 50 to 100. The preliminary concentration of rare earth impurities was accomplished in a column of silica gel that had been treated with a solution of dimethyldichlorosilane in CCl_4 and then impregnated with bis-(2-ethylhexyl) orthophosphate. It is proposed that yttrium forms a salt with the latter in the upper portion of the column. The rare earths were eluted with HCl and were coprecipitated with spectrally pure yttrium oxide if it was desired to complete the analysis with the aid of a spectrograph. An alternate procedure involves irradiation of the sample with thermal neutrons at a flux of 10^{13} n/cm^2 · sec for 20 min. This chromatographic-activation analytical method for Y in a rare earth mixture is more sensitive than the chemico-spectral method by one to three orders of magnitude. (K.S.W.)

57373 COMPARISON OF PAINTS BY NEUTRON ACTIVATION ANALYSIS. II. COLORED PAINTS. Snow, K. B.; Washington, W. D. (Internal Revenue Service, Washington, D. C.). J. Ass. Offic. Anal. Chem.; 54: No. 4, 917-19(Jul 1971). (CONF-701055-1).

From Meeting of the association of official analytical chemists; Washington, D. C. (12 Oct 1970).

A study of colored paints was made to determine to what extent individual paint samples can be characterized by neutron activation analysis. Approximately 300 samples of red, white, blue, and green paints from the major manufacturers in the United States were examined. Paints of the same color produced by different manufacturers could be distinguished by this technique. Batch-to-batch variations between paints from the same manufacturer were observed, and it was found that in a small number of cases no differences were detected. (auth)

57374 USE OF NEUTRON ACTIVATION ANALYSIS FOR THE CHARACTERIZATION OF PAPER. Brunelle, R. L.; Washington, W. D.; Hoffman, C. M.; Pro, M. J. (Internal Revenue Service, Washington, D. C.). J. Ass. Offic. Anal. Chem.; 54: No. 4, 920-4(Jul 1971). (CONF-701055-2).

From Meeting of the association of official analytical chemists; Washington, D. C. (12 Oct 1970).

A controlled study was carried out on 600 samples of various types of white and colored paper obtained from 10 different paper manufacturers with known production histories and dates. Neutron activation analysis was employed to measure the characterizing trace elemental compositions. Results indicated that (1) the papers examined were uniform with respect to their trace elemental compositions, (2) papers produced by different manufacturers are readily distinguishable qualitatively and/or quantitatively, (3) different batches of paper produced by the same manufacturer are generally qualitatively similar if produced within a short span of time (however, these specimens can be distinguished by quantitative analysis of the trace elements), and (4) different batches of paper produced by the same manufacturer at least 1 year apart are readily distinguishable qualitatively and/or quantitatively. (auth)

57375 DETERMINATION OF TRACE ELEMENTS IN SOILS AND CLAY MINERALS BY RESONANCE NEUTRON ACTIVATION ANALYSIS. Murrmann, R. P.; Winters, R. W.; Martin, T. G. (Army Natick Labs., Mass.). Soil Sci. Soc. Amer., Proc.; 35: No. 4, 647-52(Jul-Aug 1971).

Bentonites 23 and 25, Umiat bentonite, Koalinite 7, Halloysite 29, Illite 35, and Fairbanks, Barrow, and Suffield silts were irradiated with resonance neutrons by exposure of cadmium-shielded samples in a reactor for 40 hours in order to identify the elements having long half-life nuclides which could be quantitatively determined using nondestructive neutron activation analysis. By examination of the gamma spectra obtained using a high resolution Ge(Li) detector, it was possible to identify Fe, Ti, Zn, Ni, Co, Cr, Sr, Ba, Cs, La, Eu, Tb, Hf, Ta, Th, and U in most of the samples. Although quantitative results were obtained only for Fe, Ti, Zn, Ni, Co, and Cr, this method appears suitable for nondestructive quantitative analysis for all the elements identified. (auth)

57376 USE OF FAST 14-MeV NEUTRONS FOR DETERMINATION OF OXYGEN IN PURE MATERIALS. Andreev, A. V.; Pronman, I. M. Nauch. Tr., Gos. Nauch.-Issled. Proekt. Inst. Redkometal. Prom.; 22: 46-51(1968). (In Russian).

A method is described for determining oxygen in Ti, Nb, Mo, Sb, and GaAs based upon the fast neutron reaction $^{16}O(n,p)^{16}N$. The beta-emitting ^{16}N with a half-life of 7.4 sec decays with γ at 6.13 and 7.11 MeV. A gamma spectrometer was used to measure the activity of the sample, comparing the results with the activity of a standard with a known oxygen content. Standards were prepared from Plexiglas $(C_5H_8O_2)_n$, quartz (SiO_2), and marble ($CaCO_3$). The method is applicable to the majority of materials not containing significant amounts of B or F. (K.S.W.)

57377 EFFECT OF SLOWING-DOWN NEUTRONS IN THE SAMPLE ON THE RESULTS OF ACTIVATION ANALYSIS. Lisovskii, I. P.; Smakhtin, L. A.; Stariznyi, E. S. (Physical-Chemical Inst., Moscow). Zh. Anal. Khim.; 26: No. 8, 1658-9(Aug 1971). (In Russian).

The effect of increasing the flux of thermal neutrons within the mass of the irradiated sample should be taken into account during the activation determination of impurities in hydrogen-containing materials. (auth)

57378 NEUTRON ACTIVATION ANALYSIS OF TIN IN BIOLOGICAL SAMPLES BY A RAPID EXTRACTION SEPARATION OF ^{123m}Sn. Byrne, A. R. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). Radiochem. Radioanal. Lett.; 7: No. 5-6, 287-93 (10 Sep 1971).

A method was developed for determination of tin in biological materials down to 0.1 ppM by a simple and rapid radiochemical procedure for ^{123m}Sn ($T = 40$ min), based on the extraction of tin iodide into toluene. (auth)

57379 IMPURITIES IN ANALYTICAL AND SUPRAPURE REAGENTS APPLICATION OF ACTIVATION ANALYSIS FOR THE DETERMINATION OF Cl, As, Cu, Mn, Na IN MINERAL ACIDS, AMMONIA, AND HYDROGEN PEROXIDE. Kosta, L.; Ravnik, V. (Univ., Ljubljana, Yugoslavia). Radiochem. Radioanal. Lett.; 7: No. 5-6, 295-301(10 Sep 1971).

Methods were developed for checking the quality of analytical and suprapure reagents for Cl, As, Cu, Mn, and Na. A system for rapid evaporation of liquid samples under chemically sterile conditions is described. Activation analysis is shown to give suitable sensitivity and adequate precision for some very important contaminants at concentration levels in the range of 1 ng/ml and less. (auth)

57380 SUBSTOICHIOMETRIC DETERMINATION OF SELENIUM BY NEUTRON ACTIVATION ANALYSIS. Nadkarni, R. A.; Haldar, B. C. (Inst. of Science, Bombay). Radiochem. Radioanal. Lett.; 7: No. 5-6, 305-11(10 Sep 1971).

A method was developed for substoichiometric neutron activation analysis of trace amounts of selenium, based on extraction of Se(IV) with diaminobenzidine in ethyl acetate. The selenium content of the geological standard rocks T-1, W-1, Sye-1, and GR, as well as the meteorite Allende de Publito, and the biological standard kale, were determined by the proposed method. (auth)

57381 SUBSTOICHIOMETRIC DETERMINATION OF NICKEL IN STEEL BY NEUTRON ACTIVATION ANALYSIS. Doctor, Z. K.; Haldar, B. C. (Inst. of Science, Bombay). Radiochem. Radioanal. Lett.; 7: No. 5-6, 339-43(10 Sep 1971).

A rapid method for determination of traces of nickel in steel by neutron activation involving substoichiometric extraction of its dimethylglyoxime comples into chloroform is described. NBS steels, SRM 14e and SRM 10G, were analyzed for nickel by the proposed method and the results agree well with the values reported in the certificates of analyses. The time taken for radiochemical processing and counting is 15 min and the sensitivity of the method is 0.1 μg. (auth)

57382 EXPRESS DETERMINATION OF YTTRIUM IN RARE EARTH CONCENTRATES BY THE METHOD OF ACTIVATION WITH FAST NEUTRONS. Lisovskii, I. P.; Nikonov, V. N.; Smakhtin, L. A.; Sukhov, G. V.; Troyanker, L. M. (Physical-Chemical Inst., Moscow. State Scientific-Research and Design Inst. of the Rare Metal Industry, Moscow). Zh. Anal. Khim.; 26: No. 8, 1511-13(Aug 1971). (In Russian).

An express determination (2 to 4 min) of yttrium in yttroparasite concentrates is possible. The method was checked on synthetic mixtures and compared with the spectrographic emission method. The method can be used for the technological control of the industrial process. (auth)

57383 APPLICATION OF NEUTRON ACTIVATION ANALYSIS FOR THE DETERMINATION OF TRACE AMOUNTS OF BROMINE IN PULP. Johanson, M.; Fogelberg, B. C. Pap. Puu; 53: No. 5, 315-22(1971).

An examination has been made of the possibilities of the determination of bromine, and accordingly bromine-containing fungicides, in mechanical pulp and sulphite pulp by the application of direct spectrometric activation analysis. The samples were irradiated in a neutron flux in a reactor. The gamma radiation emitted by the samples was analyzed by means of a spectrometer, and the 0.55-MeV photopeak found to be a suitable basis for the quantitative determination of bromine. Experiments with known amounts of bromine showed the existence of a linear relation between the amount of bromine and the area under the 0.55-MeV photopeak. The experiments showed that minute amounts of bromine in mechanical pulp and sulphite pulp can be determined to an adequate degree of accuracy if correction is made for the background radiation of the sample. (Finland)

57384 ACTIVATION ANALYSIS OF SODIUM AND POTASSIUM IN SOLID PROPELLANTS. Barber, W. H. (Naval Ordnance Station, Indian Head, Md.); Dengel, O. H.; Vogt, R. H.; Strain, C. V. Nucl. Technol.; 12: No. 4, 381-7(Dec 1971).

Neutron activation analysis has been used to detect trace amounts of sodium and potassium in solid rocket propellants containing aluminum. The technique employs a water-pool reactor to irradiate the samples with thermal neutrons, and utilizes gamma spectroscopy to nondestructively analyze the samples for trace impurities. This technique permits precise and accurate determination of sodium and potassium in solid propellants containing as much as 20% aluminum. (auth)

57385 GAMMA-ACTIVATION METHOD FOR DETERMINING CARBON AND OXYGEN IN BERYLLIUM. Zadvornyi, A. S.; Gorenko, A. F.; Serykh, N. V.; Skakun, N. A.; Klyucharev, A. P. (Physical-Technical Inst., Kharkov). Zh. Anal. Khim.; 26: No. 9, 1841-3(Sep 1971). (In Russian).

The gamma-activation method permits a highly selective determination of 5×10^{-4} wt. % of carbon and oxygen in beryllium. There is no necessity to destroy the sample. The sensitivity can be essentially increased by decreasing the interference and increasing the gamma flux. (auth)

57386 NEUTRON ACTIVATION DETERMINATION OF COBALT BY NONDESTRUCTIVE MEANS. Lobanov, E. M.; Allabergenov, B. R.; Akbarov, U.; Nishanov, P. Kh. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 5, 87-8(1970). (In Russian).

A number of radioisotopes possess a gamma energy similar to that of ^{60}Co, and therefore interfere with the determination of the latter in a mixture. A method is described that uses an integrated coincidence spectrometer with a single-channel analyzer, passing only the total impulses from the ^{60}Co cascade radiation. In this way the Co activity was determined in samples of pyroxene, pyrite, and iron meteors after their irradiation in a reactor with a thermal flux of 1.8×10^{13} n/sec. over periods of from 1 to 10 hr. (K.S.W.)

57387 INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF ROCKS WITH A LOW-ENERGY PHOTON DETECTOR. Hertogen, J.; Gijbels, R. (State Univ., Ghent). Anal. Chim. Acta; 56: No. 1, 61-82(Aug 1971).

The usefulness of a small low-energy photon Ge(Li) detector for instrumental neutron activation analysis of silicate rocks was investigated. In order to avoid systematic errors caused by self-absorption of low-energy photons and by the counting geometry, a sample pelletizing technique is proposed. The spectral interferences in spectra taken with the small Ge(Li) detector and with a large one were compared and a definite advantage for a small detector was found for the determination of Ce, Nd, Sm, Eu, Gd, Tb, Dy, Tm, Yb, Lu, Ta, and U. (auth)

57388 CONTINUOUS NEUTRON ACTIVATION ANALYSIS. Kliment, Vladimir; Toelgyessy, Juraj (Slovenska Vysoka Skola Technicka, Bratislava). Chem. Listy; 65: No. 8, 799-822 (1971). (In Slovak).

Practical applications of neutron activation analysis for continuous analytical control are reviewed. (61 references.) (auth)

57389 DETERMINATION OF IMPURITIES IN PYROGRAPHITE BY METHOD OF DELAYED COINCIDENCES OF β AND γ RADIATION. Lobanov, E. M.; Valieva, M. G.; Sadekov, Kh. M.; Usmanova, M. M. At. Energ. (USSR); 31: No. 3, 233-5(Sep 1971). (In Russian).

The trace elements La, Nd, Ta, and W were investigated in pyrographite by the activation method of the Nsec delay in β and γ coincidences. The device is based on delayed coincidence circuits and used for the identification of different nuclei according to their excited state in lifetimes in the range of 10^{-5} to 10^{-9} sec. The characteristic γ spectrum of the decay of the given nuclear isomeric level is the final product of analysis. $\beta-\gamma$ and $\gamma-\gamma$ coincidences were used in trace analysis of pyrographite. (auth)

57390 SYSTEM FOR AUTOMATED ONE-ELEMENT ACTIVATION ANALYSIS. Venkov, S. N.; Egiazarov, B. G.; Korytko, L. A. At. Energ. (USSR); 31: No. 3, 227-32(Sep 1971). (In Russian).

A system and programs for automated instrumental activation analysis are described. A structural circuit of the system and programs of its operation and data processing permit an automated analysis of irradiated samples to be carried out in various spectrometric modes: (1) according to a chosen spectral line of the induced gamma radioactivity; (2) by a method of "spectral ratios" according to two spectral lines, taking into account a "harder" line contribution to the measurement results obtained according to a "soft" line; (3) with separation of an activity investigated through a coincidence method, etc. The capabilities of the system are illustrated by measuring oxygen and nitrogen contents in various materials and in the presence of fission products. An instrumental sensitivity of the system for the oxygen analysis is ~10^{-3}% (a single analysis), when the neutron generator output is ~10^9 n/sec and sample weight is ~5 to 10 g. Reproducibility (apparatus error) of the measurement results during many-hour operation is not worse than ±0.7%. (auth)

57391 NEUTRON ACTIVATION ANALYSIS OF ENRICHED ISOTOPES OF EUROPIUM, INDIUM, IRIDIUM, AND LUTETIUM. Vasil'ev, S. S.; Abbosov, O.; Velyus, L. M.; Kodiri, S.; Starchik, L. P. At. Energ. (USSR); 31: No. 3, 285-7(Sep 1971). (In Russian).

Samples of Eu_2O_3, Lu_2O_3, Ir, and In_2O_3 were exposed to thermal neutrons, and the gamma spectra were examined with a scintillation counter. In order to determine the ratios between the gamma intensity and the content of a given isotope, the samples were enriched to various concentrations of those isotopes. Graphs are reproduced that portray the heights of the spectral peaks at various isotopic concentrations. Because the method of determination described is only relative, a standard must be irradiated together with each unknown sample. (K.S.W.)

57392 MERCURY IN THE ENVIRONMENT. de Goeij, J. J. M.; Houtman, J. P. W. (Interuniversity Reactor Inst., Delft, Netherlands). Chem. Weekbl.; 67: 13-20(5 Mar 1971). (In Dutch). (IRI-133-71-01).

A survey of some aspects of the mercury pollution problem is given. Mercury levels are presented for Dutch fish, shellfish, birds, waters, and sediments, as well as for imported canned fish. The mercury determination was performed by neutron activation analysis and automated chemical separations. (auth)

57393 APPLICATION OF AN ELECTROCHEMICAL PRECONCENTRATION TECHNIQUE TO NEUTRON ACTIVATION ANALYSIS OF TRACE METAL IONS. Mark, Harry B. Jr. (Univ. of Cincinnati). J. Pharm. Belg.; 25: 367-99(Sep-Oct 1970).

A method is described for the determination of trace metal ions that combines electrochemical separation and neutron activation analysis. Advantages of the method are selectivity combined with sensitivity, preconcentration advantages such as elimination of hot chemical separations, ease of use of short-lived nuclides, and ability to determine several species simultaneously. (D.H.M.)

57394 DETERMINATION OF SELENIUM IN GLACIAL ICE BY RADIOACTIVATION. Weiss, Herbert V. (Naval Undersea Research and Development Center, San Diego, Calif.). Anal. Chim. Acta; 56: No. 1, 136-9(Aug 1971).

An activation procedure was developed that allows the counting of samples within 12 to 14 min after irradiation and thereby effects a twofold increase in sensitivity over other activation methods. The samples were collected and stored in polyethylene containers. The samples were dissolved in nitric acid in a quartz flask and a ^{75}Se spike added. The solution was evaporated and the residual drop diluted in water and irradiated. A radiochemical purification process was carried out, selenium precipitated, and β particles counted. After counting the ^{75}Se γ activity was measured and compared with standards. The limit of sensitivity was less than 1 ng. (M.C.G.)

57395 NEUTRON ACTIVATION STUDIES OF THE ROANOKE RIVER SYSTEM. Furr, A. Keith; Mooney, Edward (Virginia Polytechnic Inst., Blacksburg. State Univ., Blacksburg, Va.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 79-85(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A study of an unusually compact and well-defined river system containing many environmental factors leading to water pollution has been carried out by neutron activation analysis. Detailed baseline measurements of the levels of sodium, chlorine, magnesium, manganese, calcium, strontium, and aluminum were made and tests made above and below major effluent sources. (auth)

57396 USE OF (p,γ) REACTION TO DETERMINE LIGHT-ELEMENT CONTENT IN THIN SURFACE LAYERS. Vasil'ev, S. S.; Dzhemard'yan, Yu. A.; Mikhailov, G. I.; Starchik, L. P. At. Energ. (USSR); 30: No. 4, 397-8(Apr 1971). (In Russian).

Following earlier studies concerning the identification of light elements in thin surface layers by the (p,γ) reaction, an expression was derived to determine the highest yield of the reaction. Actual analytical application of the method was studied by determining the contamination by carbon of 8 semiconductor-grade silicon specimens at various stages of fabrication, such as cutting and polishing. An electrostatic accelerator was used to accelerate the protons. The carbon content was determined on the basis of the $^{12}C(p,\gamma)^{13}N$ reaction, with $T_{1/2} = 10.1$ min, $E_{\beta^+} = 1.19$ MeV and $E_\gamma \approx 2.4$ MeV. The problem was solved by examining the excitation functions of silicon, carbon, and tantalum, obtained by the irradiation of the corresponding targets; the contamination of silicon with carbon was calculated by comparing the data with the reference specimen, and Si sample containing 0.1% C. The actual contamination was obtained by calculation or by comparison of the γ and β^+ yields of the $^{12}C(p,\gamma)^{13}N$ reaction. (TTT)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 57298 and 60058.

Chemical Properties

Refer also to abstracts 57357 and 58244.

57397 (IN-1475) FIRST PRODUCT DENITRATION CAMPAIGN WITH ENRICHED URANIUM AT ICPP. Bjorklund, W. J.; Offutt, G. F. (Idaho Nuclear Corp., Idaho Falls). Jun 1971. Contract AT(10-1)-1230. 26p. Dep. NTIS.

Highly enriched uranium in the form of uranyl nitrate solution was converted to uranium trioxide in a fluidized bed denitration process at the Idaho Chemical Processing Plant. Information is presented relative to the first successful denitration campaign in which nearly 800 kg of uranium were denitrated. (auth)

57398 (NIM-1093) CALCULATION OF THE EQUILIBRIUM DISTRIBUTION OF METAL-ION COMPLEXES IN MULTICOMPONENT AQUEOUS SYSTEMS. Needes, C. R. S. (National Inst. for Metallurgy, Johannesburg (South Africa)). 23 Nov 1970. 18p. Dep. NTIS (U. S. Sales Only).

A computer program based on the generalized Newton-Raphson iterative method to solve n nonlinear implicit polynomial equations was developed to calculate the equilibrium distribution of metal-ion complexes in a multicomponent system. The method is suited to solution of a group of equations where separation of the variables is either impossible or leads to unwieldy polynomial expressions. The solutions of the three-component system $UO_2^{2+}-CO_3^{2-}-OH^-$, the four-component system $UO_2^{2+}-Fe^{3+}-SO_4^{2-}-OH^-$ and the six-component system $Cu^{2+}-Zn^{2+}-Fe^{3+}-Fe^{2+}-OH^--SO_4^{2-}$ are provided. (auth)

57399 (NIM-1144) THREE-DIMENSIONAL PREDOMINANT-AREA AND SOLUBILITY DIAGRAMS FOR THE URANYL CARBONATE AND URANYL SULPHATE SYSTEMS AT 25°C. Needes, C. R. S. (National Inst. for Metallurgy, Johannesburg (South Africa)). 4 Jan 1971. 24p. Dep. NTIS (U. S. Sales Only).

The equilibrium distribution of species in the systems $UO_2^{2+}-CO_3^{2-}-OH^-$ and $UO_2^{2+}-SO_4^{2-}-OH^-$ at 25°C was calculated by use of a computer program. The calculations were based on stability constant data taken from the literature and applied to the following conditions: total uranium concentrations of 10^{-6} to 10^{-1} M, total ligand concentrations of 10^{-4} to 10 M, and pH values between -2 and 14. The data for each of the systems were condensed into three dimensional diagrams representing the fields of predominance and solubility of the various ionic and solid species considered. (auth)

57400 PLUTONIUM(V) PEROXIDE. Musikas, C. (CEA, Fontenay-aux-Roses, France). Radiochem. Radioanal. Lett.; 7: No. 5-6, 375-9(10 Sep 1971). (In French).

Spectrophotometric evidence is given for Pu(V) peroxide formation in alkaline medium. In this medium Pu(VI) ions are reduced to Pu(V) ions. The Pu(V) peroxide is soluble and less stable than the corresponding Np(V) complex. It could be observed only at low temperature. (auth)

57401 EFFECT OF SOME RARE ELEMENTS ON NITRIFICATION BY NITRATE-FORMING BACTERIA IN SOIL SUSPENSION. Tandon, S. P.; Mishra, M. M. (Univ. of Allahabad, India). Zentralbl. Bakteriol. Parasitenk., Abt. II; 122: 155-7 (1968).

The effect of thallous sulfate, beryllium sulfate, indium sulfate, thorium sulfate, auric chloride, uranyl sulfate, and zirconium chloride on nitrate formation by Nitrobacter agilis in the soil suspension was studied and it was found that except for thallous sulfate and auric chloride, the presence of all other rare salts, accelerates the rate of nitrate formation. The rate is retarded in the presence of thallous sulfate and auric chloride. (auth)

57402 STABILITY CONSTANTS OF URANYL ION WITH MIXED CARBOXYLIC ACIDS. Ramamoorthy, S.; Balakrishnan, M. S.; Santappa, M. (Univ. of Madras). J. Inorg. Nucl. Chem.; 33: No. 8, 2713-16(Aug 1971).

A curve is given representing the titration of the mixed complex against sodium hydroxide for the uranyl ion-p-hydroxybenzoic acid–phenylacetic acid. The formation of the mixed complex of this acid was inferred from the qualitative evidence that precipitation of the system occurred at pH 5.73, while the uranyl ion–p-hydroxybenzoic acid system precipitated at pH 5.02, and uranyl ion–phenylacetic acid system precipitated at pH 5.42. The composition of the mixed complex was assumed to be 1 : 1 : 1 since neither p-hydroxybenzoic nor phenylacetic acid when titrated separately with U^{6+} tended to form complexes higher than 1 : 1. Formation of the mixed complex of uranyl ion–p-hydroxybenzoic acid–phenylacetic acid by simultaneous equilibrium was inferred from titration curves and hence the stability constant of the complex was calculated. In systems such as uranyl ion–benzoic acid–p-hydroxybenzoic acid where the precipitation point of the mixed system is in between those of the individual systems, the mixed system is found to precipitate only once and the formation of only one species was indicated. Stability constants were similarly evaluated for other uranyl complexes formed with carboxylic acids. (UK)

57403 PRECIPITATION OF SOME ACTINIDE ELEMENT COMPLEX IONS BY USING HEXAMMINE COBALT(III) CATION. III. THE PRECIPITATION OF NEPTUNIUM(VI) AND AMERICIUM(VI) SULFATE COMPLEX IONS WITH HEXAMMINE COBALT (III) CATION. Ueno, Kaoru; Hoshi, Michio. J. Inorg. Nucl. Chem.; 33: No. 8, 2631-3(Aug 1971).

The crystalline compounds $\{[Co(NH_3)_6]HSO_4\}_2[NpO_2(SO_4)_3] \cdot nH_2O$ and $\{[Co(NH_3)_6]\ HSO_4\}_2[AmO_2(SO_4)_3] \cdot nH_2O$ were prepared by addition of hexammine cobalt(III) ion to an aqueous solution of MO_2^{2+}. They are isostructural with $\{[Co(NH_3)_6]HSO_4\}_2[UO_2(SO_4)_3] \cdot 5H_2O$: cubic symmetry of the diamond type, with lattice constant a = 10.74 Å for both neptunium and americium compounds. Absorption spectra for neptunium(VI), plutonium(VI), and americium(VI) compounds in dilute sodium carbonate solution are also presented. (auth)

57404 HEPTAVALENT STATE OF NEPTUNIUM AND PLUTONIUM. Krot, N. N.; Gel'man, A. D.; Mefod'eva, M. P. Vestn. Akad. Nauk SSSR; No. 3, 57-61(Mar 1970). (In Russian).

Np(VII) is obtained by passing ozone through a suspension of sodium neptunate in alkaline medium. The intense green solution obtained has an absorption maximum at 412 and 625 nm. Pu(VII) is obtained in an analogous fashion. The heptavalent state was confirmed by spectrophotometric titration with a reducing agent. A list of other suitable oxidizing agents for producing Np(VII) or Pu(VII) is offered. Potentials of the VII/VI half cells were given as 0.6 V for Np and between 0.8 and 1.1 V for Pu. Np(VII) compounds are stable in the solid state, but Pu(VII) compounds gradually undergo a transition to the hexavalent state. Other features of the heptavalent states of these two elements are discussed in connection with other chemical reactants. (K.S.W.)

57405 SODIUM URANATES: PREPARATION AND THERMOCHEMICAL PROPERTIES. Cordfunke, E. H. P.; Loopstra, B. O. (Reactor Centrum Nederland, Petten). J. Inorg. Nucl. Chem.; 33: No. 8, 2427-36(Aug 1971).

The preparation and thermal stability of the various phases in the sodium uranate system, in which uranium has the valency of both VI and V, are described. X-ray powder data and heats of formation are given. (auth)

57406 INTERACTION OF SILICIC ACID WITH IRON(III) AND URANYL IONS IN DILUTE AQUEOUS SOLUTION. Porter, Richard A.; Weber, Walter J. Jr. (Univ. of Michigan, Ann Arbor). J. Inorg. Nucl. Chem.; 33: No. 8, 2443-9(Aug 1971).

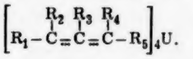
The interaction of iron(III) and uranyl ions with dissolved silica was studied by a spectrophotometric technique. The interaction with iron was studied as a function of the degree of polymerization of the silica. For uranyl ion, a complex with monomeric silica was inferred. An equilibrium constant $pQ_1 \sim 2.0$ for the equilibrium $UO_2^{2+} + Si(OH)_4 = UO_2SiO(OH)_3^{+} + H^+$ was measured. (auth)

57407 THERMAL DECOMPOSITION OF HYDROUS OXIDE AND OXYCARBONATE OF THORIUM. Saito, Yasutoshi (Akita Univ., Japan). Funtai Oyobi Funmatsuyakin; 17: No. 7, 295-9(Apr 1971). (In Japanese).

Thermal decomposition of the hydrous oxide and oxycarbonate of thorium was studied by thermogravimetry (TG), differential thermal analysis (DTA), and Hahn's emanation technique. The hydrous oxide was precipitated from a thorium salt solution by the addition of hydroxide ion. TG curves showed that the hydrous oxide gradually lost water and did not suffer from a step-by-step dehydration. DTA curves showed an endothermic peak around 150°C followed by a small exothermic peak at 250° to 300°C. In emanation curves two prominent peaks were observed, one corresponding to the 150°C peak in DTA, and the other centered at 400° to 450°C. The endothermic peak in DTA and two emanation peaks were presumed to be due to the escape of adsorbed or occluded water, and the exothermic peak in DTA due to the crystallization of the amorphous hydrous oxide. The hydrous oxide might not be hydroxide nor oxide hydrated but aquated oxide. The hydrous oxycarbonate lost water rapidly to about 200°C on heating, resulting in the formation of $ThOCO_3 \cdot H_2O$, and then followed by less rapid decomposition to the oxide. In the electron microscope, the oxide particles prepared from the hydrous oxide and oxycarbonate were irregular in the shape of agglomerates of fine primary particles. (auth) (Japan)

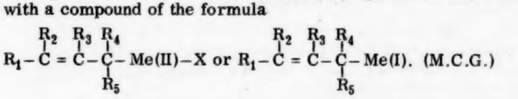
57408 π-ALLYL COMPOUNDS OF URANIUM. (to Snam Progetti SpA). British Patent 1,246,424. 15 Sep 1971. Priority date 2 May 1969, Italy.

A method is described for preparation of allyl compounds of uranium having the same general formula:



$$\left[R_1-\overset{R_2}{\overset{|}{C}}\!=\!\overset{R_3}{\overset{|}{C}}\!=\!\overset{R_4}{\overset{|}{C}}-R_5\right]_4U.$$

A suspension of a tetravalent uranium in a polar solvent is reacted with a compound of the formula



$$R_1-\overset{R_2}{\overset{|}{C}}=\overset{R_3}{\overset{|}{C}}-\underset{R_5}{\underset{|}{\overset{R_4}{\overset{|}{C}}}}-Me(II)-X \text{ or } R_1-\overset{R_2}{\overset{|}{C}}=\overset{R_3}{\overset{|}{C}}-\underset{R_5}{\underset{|}{\overset{R_4}{\overset{|}{C}}}}-Me(I).$$

(M.C.G.)

57409 COPRECIPITATION OF URANIUM WITH CALCIUM CARBONATE. Kitano, Yasushi; Oomori, Tamotsu (Nagoya Univ., Japan). Nippon Kaiyo Gakkaishi; 27: No. 1, 34-42(Feb 1971).

A study of the factors controlling the trace element content of marine calcareous skeletons is reported. The values of the distribution coefficients of UO_2^{2+} between solutions and carbonate precipitates were measured in the laboratory at 20 ± 1°C. From the determination of the uranium contents of marine calcareous skeletons and seawater, the values of uranium between marine calcareous skeletons and seawater are expected as 1.2 to 0.3 for aragonite and 0.2 to 0.0n for calcite. The experimentally measured value of the distribution coefficient for aragonite is thermodynamically discussed. The value of the distribution coefficient of UO_2^{2+} is controlled greatly by the activity coefficient of uranium dissolved in a parent medium and the crystal form of $CaCO_3$. The activity coefficient of uranium in solution is due mainly to the formation of complexes between UO_2^{2+} and CO_3^{2-} in the solution. (auth) (Japan)

57410 INFLUENCE OF IRON ON THE PHYSICOCHEMICAL STATE OF RADIOELEMENTS IN SEA WATER. Bernovskaya, R. N.; Bogdanov, Yu. A.; Gromov, V. V.; (and others). Sov. Radiochem. (Engl. Transl.); 13: No. 1, 158-60(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 157-9(Jan-Feb 1971).

The state of iron in seawater as a function of the pH of the medium was investigated with the aid of the isotope ^{55}Fe. It was shown that ^{144}Ce, ^{91}Y, and ^{95}Nb can be effectively extracted from seawater by the hydrolysis products of iron (coprecipitation), or they are sorbed on the surface of ferric hydroxide. It was hypothesized that iron, being an important biogenic element, can promote the involvement of a number of radionuclides in biological circulation. (auth)

57411 INDUCED REACTIONS IN RADIOCHEMISTRY. V. CONDITIONS DETERMINING THE REACTION YIELD IN A CLOSED SYSTEM. Posvol'skii, M. V.; Tsirlin, I. I. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 58-62(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 63-8(Jan-Feb 1971).

The dependence of the yield of the induced reaction on the initial conditions and values of the rate constants of the competing reactions of the intermediate compounds was considered in general form. It was shown theoretically that for each acceptor the inducers are divided into two groups: for the first group a 100% yield is achieved only at an infinite consumption of the inducer, and for the second at a finite consumption. The boundary between the groups lies at a value of the parameter n = 0. The results of the theoretical analysis agree with the experimental data. (auth)

57412 HEPTAVALENT STATE OF THE TRANSURANIUM ELEMENTS. XII. THE OXIDATION OF NEPTUNIUM(VI) BY POTASSIUM PERSULFATE. Shilov, V. P.; Krot, N. N.; Gel'man, A. D. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 7-11 (Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 9-14(Jan-Feb 1971).

The oxidation of neptunium(VI) to the heptavalent state by potassium persulfate at 50 to 70°C was studied in solutions with a sodium hydroxide concentration of 0.1 to 8 M. Neptunium(VI) is almost

XUM

entirely oxidized in 0.1 to 0.9 M NaOH. The reaction rate is first order with respect to persulfate. The activation energy is 33.5 l kcal/mole ($\mu = 1$ and $[OH^-] = 0.7$ g-ion/liter). The reaction is accelerated by the addition of silver, nickel, and cobalt at the level $(2-5) \cdot 10^{-6}$ M. (auth)

57413 INDUCED REACTIONS IN RADIOCHEMISTRY. VI. CONDITIONS DETERMINING THE REACTION YIELD IN AN OPEN SYSTEM. Posvol'skii, M. V.; Tsirlin, I. I.; Kochnov, V. A. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 63-6(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 68-71(Jan-Feb 1971).

The yield of an induced reaction in an open system is a function of the initial conditions, Q_I/Q_C. The influence of other factors is superimposed on this basic dependence: the initial concentration of the actor, the rate of its interaction with the inducer, the total concentration of all the components, the rate of introduction of the inducer, and its concentration in the delivered solution. The yield of an induced reaction in an open system in the case of gradual introduction of the inducer is always higher than the yield of this reaction in a closed system. (auth)

57414 INTERACTION OF NEPTUNIUM WITH HYDROGEN PEROXIDE IN CONCENTRATED SOLUTIONS OF NITRIC ACID. Krot, N. N.; Shuiskaya, L. G. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 73-7(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 79-83(Jan-Feb 1971).

Neptunium(V) in 6 to 8M HNO_3 is reversibly oxidized to neptunium(VI) and irreversibly reduced to the tetravalent state. The rate of the reversible oxidation of neptunium(V) is substantially higher than the rate of its reduction. As a result, after some period of time, the stationary equilibrium $[Np(VI)] = K_0\ [NP(V)]$, is established in solution, and does not depend on the neptunium and H_2O_2 concentrations. The value of the constant of this equilibrium at 20°C and $[HNO_3] = 7.5$ M equals 1.8 ± 0.4. After the establishment of stationary equilibrium, the rate of reduction of neptunium to the tetravalent state is described by the equation of a first order reaction with respect to the metal and first order with respect to H_2O_2. The value of the constant K at 20°C and a HNO_3 concentration of 7.5 M is (9.3 ± 0.3) liters/mole · min. The value of K decreases with decreasing HNO_3 concentration. The temperature dependence of K corresponds to a value of the activation energy of the reduction process equal to 13.2 ± 0.5 kcal/mole ($[HNO_3] = 7.5$ M). (auth)

57415 REDUCTION OF THE URANYL ION BY TITANIUM(III) IN NONAQUEOUS MEDIA. Belyaev, Yu. I.; Vdovenko, V. M.; Skoblo, A. I.; Suglobov, D. N. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 137-9(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 140-2(Jan-Feb 1971).

The reaction of $(C_{10}H_{21})_4NUO_2Cl_3$ with $TiCl_3$ was investigated in various solvents (dimethylformamide, methanol, TBP, acetone, acetonitrile), and its stoichiometry was established. It was shown that in all the media studied at 20° there is a rapid reduction of UO_2^{2+} to U^{4+}, with the formation of TiO^{2+} and UCl_6^{2-} (dimethylformamide, acetonitrile), UCl_5^- (TBP, acetone), and UCl_4 (methanol). The reaction products were identified by ir and visible spectra. The high reaction rate and the absence of influence of the solvent support its "intrasphere" mechanism, in which there is a direct contact of the coordination spheres of U(VI) and Ti(III) in the process of transfer of an electron and oxygen. (auth)

57416 FORMATION OF HYDRATES OF URANIUM(VI), GADOLINIUM, AND TERBIUM PEROXIDES UNDER THE ACTION OF ULTRAVIOLET LIGHT. Dobrolyubskaya, T. S. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 140-3(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 143-6(Jan-Feb 1971).

Changes in the luminescence and absorption spectra of dilute sulfuric acid solutions of uranium(VI), gadolinium, and terbium were studied in the case of prolonged irradiation with ultraviolet light. As a result of the influence of light, an impurity of hydrates of peroxide compounds is formed in the solutions, and the tendency for their formation is most pronounced for gadolinium, less for uranium, and to a very negligible degree for terbium. The mechanism of the photochemical process is discussed. (auth)

57417 INTERACTION OF AMORPHOUS URANIUM TRIOXIDE WITH CARBON MONOXIDE. Bessonov, A. F. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 147-9(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 148-50(Jan-Feb 1971).

Data on the reaction were obtained with a high-temperature x-ray camera and complex dilatometric apparatus. The conversions that occur in the reduction of amorphous UO_3 by CO can be depicted by the following scheme: $UO_{3(am)} \rightarrow U_3O_{8(tx)}^{hex} \rightarrow U_4O_9 \rightarrow UO_{2+x} \rightarrow UO_2$. (M.C.G.)

57418 COPRECIPITATION OF RADIUM WITH A PROTOTYPE OF THE BONE MINERAL CALCIUM HYDROXYLAPATITE. Popov, D. K.; Mikhailova, A. I.; Basalaeva, L. N. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 150-2(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 151-3(Jan-Feb 1971).

The coprecipitation of radium with recrystallized calcium hydroxylapatite (an analog of bone mineral) is entirely due to isomorphous cocrystallization. The distribution of radium is very close to the distribution of strontium and barium. The solid phase is impoverished in microcomponents with respect to calcium. Like barium, radium coprecipitates more completely than strontium with fresh portions of hydroxylapatite. It is suggested that the increased trapping of barium and radium by fresh precipitates is explained by their volume coprecipitation with the precrystalline calcium phosphate present in fresh precipitates of hydroxylapatite and representing an analog of the exchange component of the bone mineral. In such a case the lower retention of the radioactive isotopes of barium and radium by the organism in comparison with the retention of strontium isotopes is probably due to the fact that the heavy elements of the alkaline earth group are primarily concentrated in the rapidly exchanged component of the bone mineral. (auth)

57419 PREPARATION OF ANHYDROUS URANIUM TETRACHLORIDE AND MEASUREMENTS ON ITS MAGNETIC SUSCEPtibility. Yoshimura, Tetsuhiko; Miyake, Chie; Imoto, Shosuke (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 9, 498-502(Sep 1971).

The reaction of UO_2 with CCl_4 vapor was carried out in a vacuum of 10^{-5} mmHg at 500°C in order to prepare UCl_4 of high purity. The lattice parameters were calculated from x-ray analysis to be $a_0 = 8.278 \pm 0.002$, $c_0 = 7.460 \pm 0.009$. The product thus obtained was verified by chemical and x-ray analyses to be of anhydride form. The magnetic susceptibility was measured over the temperature range from liquid N_2 to liquid He temperature, which revealed a deviation from the straight $1/\chi - T$ relation toward lower temperature. (auth)

57420 ELECTROCHEMISTRY OF Pu(III) IN MOLTEN LiCl–KCl EUTECTIC. Martinot, L.; Duyckaerts, G. (Lab. of Nuclear Chemistry, Liege). Anal. Lett.; 4: No. 1, 1-11 (Jan 1971).

A chronopotentiometric study of the reactions Pu(III) → Pu(IV) + e^- in molten LiCl–KCl eutectic is reported. The diffusion coefficient $D_{Pu(III)}$ increased from $4.8 \cdot 10^{-6}$ to $27.6 \cdot 10^{-6}$ $cm^2\ sec^{-1}$ when the temperature was raised from 400 to 650°C. An estimate of the activation energy of the electrochemical reaction is also reported. (auth)

Isotope Effects and Exchange

Refer also to abstracts 57490, 57493, 57545, and 59196.

57421 INFRARED BANDS OF $H^{12}C^{15}N$, $D^{12}C^{15}N$, AND $H^{13}C^{15}N$. Alpert, B. D.; Mantz, A. W.; Rao, K. Narahari (Ohio State Univ., Columbus). J. Mol. Spectrosc.; 39: No. 1, 159-62(Jul 1971).

Infrared spectra of some of the isotopic varieties of the hydrogen cyanide molecule were measured employing high precision vacuum grating spectrographs. Several bands of $H^{12}C^{15}N$, $D^{12}C^{15}N$, and $H^{13}C^{15}N$ occurring in the 2 to 7 μ region are reported for the first time. Molecular constants were derived from these data. (auth)

57422 NORMAL COORDINATE ANALYSIS OF ETHYL CHLORIDE AND SOME DEUTERATED DERIVATIVES. Dempster, A. B.; Zerbi, G. (Istituto di Chimica delle Macromolecole, Milan). J. Mol. Spectrosc.; 39: No. 1, 1-7(Jul 1971).

A recently published force field for alkyl chlorides was slightly refined as a result of normal coordinate analysis calculations to fit the vibrational spectra of ethyl chloride-d_0, -d_2, -d_3, and -d_5. In doing so it was possible to clarify some problems raised in previous work concerning the experimental bands to be ascribed to fundamentals and to obtain a quantitative description of the normal modes. (auth)

57423 ROTATIONAL CONSTANTS FOR HCN AND DCN. Winnewisser, Gisbert (National Research Council, Ottawa); Maki, Arthur G.; Johnson, Donald R. J. Mol. Spectrosc.; 39: No. 1, 149-58(Jul 1971).

Microwave measurements of rotational transitions within vibrationally excited states of several isotopic species of HCN have given improved values for the pertinent B_v constants. These new data have been combined with infrared measurements given in the literature (including D_v terms) to arrive at a set of rovibrational constants (α and γ constants) which is consistent with all available data. Bond distances resulting from several different B_e approximations are intercompared to assess the variability of the r_e values and the importance of the γ terms. The latest r_0 and r_s bond distances are also given. (auth)

57424 ROTATIONAL SPECTRA OF NH_3 AND ND_3 IN THE 0.5-mm WAVELENGTH REGION. Helminger, Paul; De Lucia, Frank C.; Gordy, Walter (Duke Univ., Durham, N. C.). J. Mol. Spectrosc.; 39: No. 1, 94-7(Jul 1971).

Rotational transitions of NH_3 and ND_3 in the 0.5-mm wavelength region were observed and measured by microwave techniques. For ND_3 the two inversion components of the $J = 1 \rightarrow 2$ transitions of $^{14}ND_3$ and $^{15}ND_3$ at 0.49-mm wavelength were measured, and for NH_3 the $J = 0 \rightarrow 1$ transitions of $^{14}NH_3$ and $^{15}NH_3$ at 0.52-mm wavelengths have been remeasured with higher precision. With $J = 0 \rightarrow 1$ transition frequencies for ND_3 from previous microwave measurements and with the centrifugal stretching constant D_J for NH_3 measured in the infrared region, these frequencies yield the following spectral constants (in Mc/sec): for $^{14}ND_3$, $B_0 = 154\ 173.38$, $D_J = 5.91$, $D_{JK} = -10.49$; for $^{15}ND_3$, $B_0 = 153\ 600.97$, $D_J = 5.92$, $D_{JK} = -10.54$; for $^{14}NH_3$, $B_0 = 298\ 115.37$; and for $^{15}NH_3$, $B_0 = 297\ 388.12$. The effective ground-state structural dimensions for NH_3 are $d_{NH} = 1.0156$ Å and $<HNH = 107°17'$, and the corresponding values for ND_3 are $d_{ND} = 1.0143$ Å and $<DND = 107°4'$. Various substitution structures are also calculated. (auth)

57425 HMO ESTIMATION OF IODINE EXCHANGE RATES BETWEEN SUBSTITUTED ARYL IODIDES AND ALKALI IODIDES. Spevacek, V. (Inst. of Nuclear Research, Rez, Czech.). Radiochem. Radioanal. Lett.; 7: No. 5-6, 367-74(10 Sep 1971).

A procedure is described for estimation of isotope exchange rates between substituted aryl iodides and inorganic iodides, from localization energies (ΔW) calculated on the basis of the Hückel MO theory. The following correlation was found between the second order rate constants ($l \cdot mol^{-1}\ s^{-1}$) at 195°C and the localization energy: $\log k \pm 1.0 = -22.7\ \Delta W + 80.0$. The effect of electrolytic dissociation on the rate in organic solvents is discussed. (auth)

57426 ORDERING OF CARBON–HYDROGEN BOND STRENGTHS USING ISOTOPE EFFECTS. Lewis, Edward S.; Butler, Murdock M. (Rice Univ., Houston, Tex.). J. Chem. Soc., D; No. 16, 941-2(25 Aug 1971).

Variations in the tritium isotope effects in the radical addition of R^1SH to $R^2R^3C{=}CH_2$ are interpreted in terms of the transition state symmetry, measured by the difference in bond strengths to hydrogen in the initial state ($R^1S{-}H$) and the final state ($H{-}CR^2R^3CH_2SR^1$). (auth)

57427 DEUTERIUM SOLVENT ISOTOPE EFFECTS IN METHANOL SOLUTION. PART I. FRACTIONATION FACTORS FOR LYONIUM AND LYATE IONS. Gold, V.; Grist, S. (King's Coll., London). J. Chem. Soc., B; No. 8, 1665-70(1971).

The deuterium fractionation factors $[(D/H)_{solute}/(D/H)_{solvent}]$ for hydroxylic positions were determined by the nmr method for the methanolic hydrogen ion (0.62_5) and the methanolic methoxide ion (0.74). The effect of counterions was taken into account in the evaluation of fractionation factors. The existence of significant hydrogen isotope fractionation involving distinguishable hydroxylic positions created by the dissolution of sodium methoxide in methanol is consistent with other evidence for hydrogen-bonding solvation of lyate ions. The deuterium isotope effect on the ionic product of methanol (K_H/K_D) is calculated to be ca. 6.3. (auth)

57428 ISOTOPE EFFECT STUDY IN CATALYTIC EXCHANGE OF ETHANE. Guczi, L.; Sarkany, A.; Tetenyi, P. (Inst. of Isotopes, Budapest). Z. Phys. Chem. (Frankfurt); 74: No. 1-2, 26-31(1971).

Catalytic hydrogen exchange was studied between ethane and deuterium- as well as tritium-labeled hydrogen on nickel catalyst. A comparison of the ratio of the initial rates obtained by using tritium- and deuterium-labeled hydrogen to that of tritium to deuterium in hydrogen gas showed that there is no kinetic isotope effect with respect to the hydrogen isotopes. The simultaneous investigation of $H_2{-}D_2$ exchange on the same catalyst shows that the rate of $H_2{-}D_2$ conversion is much higher than that of hydrogen exchange in ethane; therefore, the experimental fact found for the kinetic isotope effect by using heavy and light hydrocarbons is correct and it is not influenced by the difference in the bond strength between Ni–H and Ni–D. (auth)

57429 PROTON MAGNETIC RESONANCE STUDY ON LIGHT- AND HEAVY-WATER SOLUTIONS OF Be(II). Farkas, A.; Tataru, E. Stud. Univ. Babes-Bolyai, Ser. Phys.; 16: No. 1, 79-81(1971).

The presence of deuterium in an aqueous solution of Be(II) evokes a change in the proton magnetic resonance spectrum under high resolution. Isotopic effects are evident, arising in the width of the signal within the temperature range 17.5 to 70°C. It appeared that the total sphere of hydration was richer in protons than free water. Isotopic chemical displacements were used for ionic complexes. The values are proportional to the concentration of deuterium and arranged in the direction of the weaker field. (tr-auth)

57430 RELATIVE TRITIUM–DEUTERIUM ISOTOPE EFFECTS IN THE ABSENCE OF LARGE TUNNELING FACTORS. Stern, Marvin J.; Vogel, P. Christian (Yeshiva Univ., New York). Contract AT(30-1)-3663. J. Amer. Chem. Soc.; 93: No. 19, 4664-75(22 Sep 1971).

Model calculations are used to investigate relative tritium–deuterium kinetic isotope effects and their temperature dependences. It is shown that, in the harmonic approximation and in the absence of large tunneling factors, relative effects, defined as $r = \ln(k_H/k_T)/\ln(k_H/k_D)$, are generally restricted to the range $1.33 \leq r \leq 1.58$, within the temperature interval 20 to 1000°K, provided that the individual tritium and deuterium effects are themselves reasonably large, in the normal direction ($k_{light} > k_{heavy}$), and exhibit "regular" temperature dependences at all temperatures. Overall, however, deviations from this range should not be rare. The extent of deviation usually increases with the degree of irregularity of the temperature dependences (temperature-dependence "anomalies") of the individual tritium and deuterium isotope effects. In addition, inverse isotope effects, even those with regular temperature dependences, will usually exhibit ill-behaved relative isotope effects because of the omnipresence in such cases of higher temperature "inversions," where the signs of $\ln(k_H/k_{D(T)})$ change from negative to positive. The relative isotope effect can start to reflect the presence of an inversion or anomaly in the individual effect(s) several hundred degrees away from the inversion temperature or anomalous region. The results of this study, when combined with the results of previous studies of the temperature dependences of individual isotope effects, indicate that the usual estimates of r may be used reliably to calculate deuterium isotope effects from measured tritium effects, or vice versa, only with sizable magnitude, pure primary, normal direction individual isotope effects and mixed primary–secondary normal direction individual isotope effects of sufficiently large magnitudes to be principally manifestations of the primary substitutions. Similarly, deviant values of relative tritium–deuterium isotope effects may be used to investigate factors such as quantum mechanical tunneling only under the same conditions. Fortunately, these are the conditions most likely to be involved in a study of tunneling. (auth)

57431 MANDELALDEHYDE–2-HYDROXYACETOPHENONE ISOMERIZATION. Griffiths, David W.; Gutsche, C. David (Washington Univ., St. Louis). J. Amer. Chem. Soc.; 93: No. 19, 4788-94(22 Sep 1971).

As a model system for gaining information about glyceraldehyde–dihydroxyacetone isomerization, the interconversion of mandelaldehyde and 2-hydroxyacetophenone was studied. Using mandelaldehyde and deuteriomandelaldehyde, isolated and added to the reaction mixture in the form of the dimers, with anhydrous pyridine and aqueous pyridine (H_2O and D_2O) as the basic catalyst, evidence was adduced to support the generally accepted enolization mechanism for the isomerization. The rate of the reaction shows a dependence on protic species, including the substrates and products themselves and is in accord with the expression rate = $(\Sigma k_i[HA]_i)$ [mandelaldehyde dimer] [pyridine]. A deuterium isotope effect of ca. 1.3 is observed which, when corrected for the apparently differing amounts of aldehyde form in equilibrium with the proteo dimer and the deuterio dimer, gives a value of ca. 3.9. From the rates of isomerization of p-methoxy-, p-methyl-, p-chloro-, and p-trifluoromethylmandelaldehyde (used as the dimers) a Hammett ρ constant of 1.4 ± 0.1 is calculated. The observed rates with trifluoroethanol, 2-pyridone, phenol, 2-hydroxymethylpyridine, 2-(β-hydroxyethyl)pyridine, 2-(γ-hydroxypropyl)pyridine, and benzoic acid indicate a Brønsted catalytic constant of 0.11 to 0.15 if the difference in pK_a values between water and pyridine solution is taken into account. Benzamidine was found to be a very much more effective catalyst than other bases of comparable basicity or other acids of comparable or greater acidity. Although these data do not allow a clean choice between the ring-opening step and the enolization step as the rate-determining event, the latter is considered to be more likely and is thought to require both a base (i.e., pyridine) and an acid (e.g., a protic species) catalyst. (auth)

57432 MECHANISM OF A RATE-CONTROLLED CROSS-DISPROPORTIONATION BETWEEN PHENOXYL RADICALS.

XUM

Adam, Waldemar; Chiu, Wen Tzong (Univ. of Puerto Rico, Rio Piedras). J. Amer. Chem. Soc.; 93: No. 15, 3687-93(28 Jul 1971).

The reaction of galvinoxyl with trihydrogalvinoxyl leads to hydrogalvinoxyl in the stoichiometric proportions of 2 : 1 : 3, respectively. The experimental rate law, measured by following the decay of the galvinoxyl ESR signal, was found to be second order in galvinoxyl, first order in trihydrogalvinoxyl, and inverse order in hydrogalvinoxyl. The activation parameters were $\Delta H^\ddagger$ = 7.7 kcal/mole and $\Delta S^\ddagger$ = −42.8 gibbs/mole, indicating that steric congestion is the principal factor in the rate-limiting step. The isotope effect for hydrogen transfer from carbon to oxygen was found to be 3.6, but no isotope effect for hydrogen transfer from oxygen to oxygen was observed. This implies that the methylene hydrogen of trihydrogalvinoxyl rather than the hydroxyl hydrogen is transferred in the slow step. Although the free energy of activation and thus the rates of hydrogen transfer were constant in a large number of diverse solvents, it was found that $\Delta H^\ddagger$ and $\Delta S^\ddagger$ for the hydrogen transfer in benzene, acetone, acetonitrile, and cyclohexane followed a linear relationship with an isokinetic temperature of 293.8°K. The mechanism is discussed in terms of initial fast reversible oxygen−oxygen hydrogen transfer between galvinoxyl and trihydrogalvinoxyl, followed by rate-controlled cross-disproportionation between galvinoxyl (G) and the dihydrogalvinoxyl (GH_2) radical. (auth)

57433 ENERGY LEVELS AND MOLECULAR CONSTANTS OF $^{12}C_2H_2$, $^{12}C_2D_2$, $^{12}C_2HD$ DETERMINED FROM INFRARED SPECTRA. Hurlock, S. C.; Ghersetti, Sergio; Rao, K. Narahari (Ohio State Univ., Columbus. Univ., Bologna). Mem. Soc. Roy. Sci. Liege; 1: No. 2, 87-97(1971).

An attempt was made to bring together the best available values for the energy levels and molecular constants of the ground electronic states of the acetylene molecule and some of its isotopic species. What were believed to be internally consistent data obtained from high resolution infrared spectra are included. (auth)

57434 DIFFUSION COEFFICIENTS OF ISOTOPIC METHANE MIXTURES AND OF METHANE–RARE GAS MIXTURES. Vugts, H. F.; Boerboom, A. J. H.; Los, J. (FOM.-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Mem. Soc. Roy. Sci. Liege; 1: No. 2, 179-85(1971).

Relative diffusion coefficients were measured for three systems: CD_4-CD_3H, CD_3H-Ne, and CD_3H-Ar in the temperature range 230 to 425°K with an accuracy of 0.1%. Absolute diffusion coefficients for these mixtures could be obtained by normalizing on the self diffusion data of argon. Concerning the isotopic methane mixture theoretical calculations bearing on $(\epsilon/k)_{diff.}$ and Z_{rot} were found to be in close agreement with our experimental data. For rare gas−molecular gas mixtures explicit values for 6C-5 are given, which in the case of $Ne-CD_3H$ can be correlated with Z_{rot} based on a loaded sphere model. For $T^* < 3$ the loaded sphere model shows to be less applicable as is evident from the results of $Ar-CD_3A$. (auth)

Physical Chemistry

Refer also to abstracts 58372, 58379, 58390, and 60124.

57435 (COO–1029-39) HIGH TEMPERATURE CHEMISTRY: FUNDAMENTALS OF EFFUSION AND THERMODYNAMICS OF MATERIALS. Final Report, June 1, 1961–August 31, 1971. Wahlbeck, Phillip G. (Illinois Inst. of Tech., Chicago. Dept. of Chemistry). Contract AT(11-1)-1029. 130p. Dep. NTIS.

A publication list of research completed under this contract is presented, and tentative results are given for research now in progress on the dissociation energy of ScSe, YSe, LaSe, and TiO. (D.H.M.)

57436 STRUCTURE AND CONFORMATION OF THORIUM(IV) COMPLEXES OF DIETHYLENETRIAMINEPENTAACETIC ACID IN AQUEOUS SOLUTION. Fried, A. R. Jr.; Martell, A. E. (Texas A and M Univ., College Station). Contract AT(40-1)-3621. J. Amer. Chem. Soc.; 93: No. 19, 4695-4700(22 Sep 1971).

The aqueous (D_2O) infrared and proton NMR spectra of the 1 : 1 complexes of thorium(IV −diethylenetriaminepentaacetic acid (DTPS) were studied as a function of "a" value a = moles of base added/mole of metal ion). On the basis of ir and NMR data, plausible solution structures are proposed and compared with proposed structures from previous potentiometric studies. Unlike the 10^{-3} M potentiometric study of Th(IV) −DTPA at a = 0, the 0.10 M ir and NMR spectra at a = 0 confirm the presence of a 1 : 1 complex in which the ligand is pentadenate. A structure is proposed for the 1 : 1 DTPA complex at a = 5 (pD 5.3) on the basis of the NMR spectra. Infrared and NMR data for the complex at a = 6 (pD 10.24 indicate that the monohydroxo chelate is nine-coordinate. (auth)

57437 ELECTRON-TRANSFER AND f → d ABSORPTION BANDS OF SOME LANTHANIDE AND ACTINIDE COMPLEXES AND THE STANDARD (III–IV) OXIDATION POTENTIALS FOR EACH MEMBER OF THE LANTHANIDE AND ACTINIDE SERIES. Nugent, L. J.; Baybarz, R. D.; Burnett, J. L. (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 33: No. 8, 2503-30(Aug 1971).

Best values for the standard (III− IV) oxidation potentials for each member of the lanthanide series and for each member of the actinide series are obtained from a variety of sources, namely, from the direct electrode measurements reported in the literature, from linear plots of electron-transfer absorption band energy for various Ln(IV) and An(IV) complexes versus the respective (III−IV) potentials, from linear plots of f → d absorption band energy for various Ln(III) and An(III) complexes vs the respective (III−IV) potentials, and from theoretical correlations using Jørgensen's refined-electron-spin-pairing-energy theory. Two major results of this work are that the M(III−IV) potentials for M ≐ Cm, Cf, Pr, and Tb are all within −3.2 ± 0.3 V, and the indication that the unknown oxidation states Cf(IV), Es(IV), Pm(IV), Sm(IV), Fm(IV), and possibly Md(IV), listed in the order of decreasing stability, may be stabilized in various media. Altogether, the results are in excellent accord with the actinide hypothesis. (auth)

57438 THEORY OF THE ACTINIDES. Chaikhorskii, A. A. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 1-6(Jan-Feb 1971).
Translated from Radiokhimiya; 13: No. 1, 3-9(Jan-Feb 1971).

Rules of analog lines in the Mendeleev periodic law are considered. The necessary requirements for the new principle of incompatability, based on a system of five quantum numbers, are outlined. On the basis of the rule of analog lines, the principle of incompatability, and other physicochemical properties of the 4f- and 5f-elements, the "thoride" hypothesis is proposed. (auth)

57439 ELECTROMIGRATION OF IONS OF ^{22}Na, ^{42}K, ^{86}Rb, AND ^{134}Cs IN MOLTEN CHLORIDES. Shvedov, V. P.; Osipov, V. N. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 92-6(Jan-Feb 1971).
Translated from Radiokhimiya; 13: No. 1, 98-101(Jan-Feb 1971).

The mobilities of ions of ^{22}Na, ^{42}K, ^{86}Rb, and ^{134}Cs in molten chlorides of these elements were determined at various temperatures, considering the influence of evaporation on the electromigration of the ions. In the temperature interval investigated, the mobilities of the impurity ions are equal to the mobility of the cation of the background melt itself within the limits of experimental error. At temperatures close to the melting points of the chlorides, the rate of migration decreases with increasing radius of the cation of the background electrolyte. With increasing temperature, the nature of this dependence changes. The inverse proportionality between the ion mobility and the crystal chemical radius of the ion is not always fulfilled. The activation energy of the mobilities of sodium, potassium, and rubidium ions is equal to the activation energy of the mobility of cesium in cesium chloride. The experimental results obtained can be explained by association in the melts investigated. The transport numbers of the cations and anions were determined in sodium, potassium, rubidium, and cesium chlorides. The values obtained for the transport numbers are in good agreement with the data found by the Gittorf method. The material of the porous medium in which the ions move evidently has no appreciable influence on the electromigration of the ions. (auth)

57440 APPLICATION OF LAYERS OF Th, U, Np, AND Pu ON INSTRUMENT PARTS BY THE METHOD OF ELECTROLYTIC DEPOSITION. Reformatskaya, I. A. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 84-7(Jan-Feb 1971).
Translated from Radiokhimiya; 13: No. 1, 89-94(Jan-Feb 1971).

A method for electrolytic application of layers of oxides of U, Th, Np, and Pu on parts of industrial instruments from solutions of their nitrates in organic alcohols was developed. Uniform and rather strong layers with a surface density of the coating of 0.2 to 5 mg/cm^2 for U and Th and 0.2 to 1.5 mg/cm^2 for Np and Pu were obtained by the method of multilayer electrodeposition on stainless steel substrates. The method permits quantitative (up to 98.5%) solution of an element from a solution of an electrolyte in 20 to 45 min at a current density of 2 to 7 mA. The method gives well reproducible results. (auth)

57441 CHEMICALLY STABLE ELECTRODE MATERIAL IN LIQUID IRON. Kawakami, M.; Goto, K. (Tokyo Inst. of Tech.). Met. Trans.; 2: No. 10, 2965-6(Oct 1971).

V_2O_3 was tested as a possible electrode material in liquid Fe for electric or electrochemical measurements. After immersion in liquid Fe for an hour, a thin FeV_2O_4 layer was formed on the V_2O_3 rods, but the V content in the Fe was virtually zero.

V_2O_3 was found to be stable in H_2 and Ar streams at 1550°C. The electric conductivity of V_2O_3 was found to be high ($\log \sigma = 3.17 - 1.0 \times 10^3$ T) with no rectifying action. The emf of the cell Mo, MoO_2/ZrO_2, CaO/liquid Fe, V_2O_3 was found to be stable for 1 hr at 1550°C. (D.L.C.)

Radiation and Nuclear Chemistry

57442 SOME PROBLEMS OF NUCLEAR CHEMISTRY. Gol'danskii, V. I. Vestn. Akad. Nauk SSSR; No. 9, 73-84(Sep 1969). (In Russian).

The work of the Institute of Chemical Physics and similar institutes of the Academy of Sciences in the USSR is summarized. "Hot atom" chemistry is exemplified by an investigation of neutron-irradiated systems containing a sulfur-containing organic compound and either HCl or CCl_4. Introduction of a 16.5-keV ^{35}S atom into the system from the reaction $^{35}Cl(n,p)^{35}S$ offers a large probability of replacing the nonradioactive S by ^{35}S. Replacements of 7 to 60% are reported. The fixation of nitrogen in the form of NO_2, NH_3, or HCN in various gaseous systems (e.g., $N_2 + CH_4$) by means of heavy ions did not produce greater yields than found for protons, electrons, and gamma radiation. Symmetrical and asymmetrical doublets of quadripolar splitting of Moessbauer spectral lines were obtained. The Zeeman splitting of spectral lines of ^{119}Sn was observed in (Y,Ca, Sn,Fe,O) complexes, and it was established that Sn was connected to Fe through an oxygen bridge. Spectra of 4-coordinate yellow complexes of Fe with compounds such as methylnaphthyldithiol and α-nitroso-β-naphthol furnished evidence as to the choice between planar vs distorted structural forms of the Fe-coordination bonding. A detailed list of similar phenomena under study is set forth. (K.S.W.)

57443 ELECTRON IRRADIATION OF DILUTE AQUEOUS SOLUTIONS OF POLYMERS OVER A RANGE OF TEMPERATURES. Davies, J. M.; Zagieboylo, W. (Army Natick Labs., Mass.). Int. J. Appl. Radiat. Isotop.; 22: No. 9, 521-8(Sep 1971).

Dilute aqueous solutions of carboxy methyl cellulose (CMC) and gelatin were irradiated with 1-MeV electrons over the temperature range from +25°C to very low temperatures, −70 to 170°C. The effects, chain scission in CMC and crosslinking in gelatin, were measured by determining the viscosity change of CMC solutions and the insoluble gel fraction produced in gelatin solutions. For both solutions there was a great change in the effect near the freezing temperature, but there were some differences in behavior between the two materials. With CMC there was a sharp break near 0°C with the rate of change 37 times as great above 0°C as below 0°C; there was apparently no change from ~0°C down to −170°C. With gelatin the change was somewhat more gradual near freezing. The rate was 7.5 times as great at +5°C as at −5°C, with a continual change over that temperature range and a continuing change in rate down to −70°C. The crosslinking rate depends on the mobility of the polymer chains and apparently for the gelatin solutions the mobility continues to decrease as the temperature is lowered below freezing. (auth)

Radiation Effects

Refer also to abstracts 58160 and 58416.

57444 INFLUENCE OF IONIZING RADIATION ON THE CATALYTIC ACTIVITY OF IRON CATALYSTS FOR AMMONIA SYNTHESIS. Stepan, O.; Stverak, B. (Inst. for Research, Production, and Use of Radioisotopes, Prague). Collect. Czech. Chem. Commun.; 36: No. 6, 2358-61(Jun 1971).

The effects of the following factors on the catalytic activity of iron in the synthesis of ammonia were investigated: activation in a reactor, incorporation of ^{90}Y, and irradiation with ^{60}Co γ radiation. Irradiation in the reactor resulted in a decrease in rate constants and an increase of activation energies. A higher catalytic activity was found in radioactive catalysts. No effects were observed from γ irradiation. (M.C.G.)

57445 UNSTABLE INTERMEDIATES. PART XCVIII. ELECTRON SPIN RESONANCE SPECTRA FOR VARIOUS ANTIMONATE RADICALS IN γ-IRRADIATED POTASSIUM ANTIMONATE AND SODIUM HEXAFLUOROANTIMONATE. Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 14, 2393-6(1971).

Exposure of potassium antimonate to ^{60}Co γ-rays gave a radical whose ESR spectrum was close to that expected for SbO_4^{2-} radicals. Similar treatment for sodium hexafluoroantimonate gave a radical with a comparable ESR spectrum, suggesting that the species is of the form $\dot{O}-SbX_\alpha$ rather than SbF_5- or SbF_6^{2-}, as previously suggested. (auth)

57446 THERMOSTABILIZATION OF IRRADIATED FILLED POLYETHYLENE. Yanson, I. R.; Karlivan, V. P.; Kal'kis, V. Ya.; Rayave, E. L. (Inst. of Physics, Riga). Modif. Polim. Mater.: No. 2, 100-6(1969). (In Russian).

An investigation was conducted on thermostability of irradiated filled polyethylene, where the filler was identified as one of the following: kaolin, chalk, talc, Fe_2O_3, SiO_2, TiO_2, and Al. Toughness and percent elongation of samples were measured and compared with those of unfilled polyethylene as a means of evaluation. The nature of the filler significantly affected the shape of the stability–time curves. The effectiveness of thermostabilization depended both on the filler used (15% by weight) and the antioxidant incorporated (2%) in the polyethylene. The best antioxidants among those tested were 2,2'-thiobis(6-tributyl-p-cresol) (CaO-6), and di-β-naphthyl-n-phenylenediamine. Light stability was greatly enhanced by the combined use of antioxidant CaO-6 and the light absorber Tinuvin 326. (K.S.W.)

57447 STRUCTURE OF IRRADIATED TELLURITE GLASSES. Galimov, D. G.; Sherstyuk, A. I.; Yudin, D. M.; Yakhkind, A. K. Zh. Strukt. Khim.; 12: No. 3, 408-14(May-Jun 1971). (In Russian).

The electron paramagnetic resonance spectra of γ-irradiated tellurite glasses were investigated. A sodium–tellurium glass containing 18 mole % Na_2O constituted the basic matrix, and to this was added small amounts of a series of oxides, e.g., La_2O_3, Eu_2O_3, Yb_2O_3, and MnO_2. Samples of these glasses were irradiated with ^{60}Co-radiation at 40°C. The EPR spectra were taken at the temperature of liquid nitrogen: two types were found with $g_1 = 2.00$ and $g_2 = 1.97$, which were associated with octahedral and tetrahedral structural forms in the tellurite glasses. The problems of these structures are discussed. (K.S.W.)

57448 EFFECTS OF NUCLEAR RADIATION ON THE ACTIVITY OF A PALLADIUM CATALYST FOR THE HYDROGENATION OF BUTYNEDIOL. Sokol'skii, D. V.; Nadykto, B. T.; Pak, A. M.; Korolev, A. V. At. Energ. (USSR); 31: No. 3, 283-5(Sep 1971).

The changes in catalytic activity of palladium black caused by various exposures to neutron fluxes were studied. The integrated thermal neutron fluxes used were generated in a nuclear reactor and were 1.6×10^{16} and 1.6×10^{19} n/cm^2, respectively; the former exposure resulted in distinctly improved catalytic properties by a factor of 2.6 by reducing the particle size and increasing the specific surface from 68.2 to 100.0 m^2/g. The yield of butenediol was increased from 73 to 89%. (K.S.W.)

57449 ESR STUDY OF VANADYL ION IN AN IRRADIATED VANADO COMPLEX. Srinivasan, R.; Subramanian, C. K. (Indian Inst. of Science, Bangalore). Indian J. Pure Appl. Phys.; 9: No. 1, 24-6(Jan 1971).

An ESR study of x- or uv-irradiated diamagnetic $(NH_4)_3[VO_2(C_2O_4)_2]2H_2O$ revealed the formation of oriented stable vanadyl ions in the host lattice. The centers were found to be stable when trapped in the crystalline state but were chemically unstable. ESR absorption of the irradiated sample, even after storage for one year, indicated the stability of these centers. The unpaired electrons of the center studied appear to exist in the d_{xy} orbital of the vanadium ion. Previously reported molecular orbital calculations and optical absorption results were used along with the ESR data to reveal a covalent in-plane σ bond and an out-of-plane ionic π bond. (auth)

Radiation Processes

57450 (ORO–3667-1) RESEARCH AND DEVELOPMENT STUDIES INTO THE BASIC TECHNOLOGY OF RADIATION INDUCED IONIC POLYMERIZATION INCLUDING SMALL SCALE PILOT PLANT SYSTEMS. Final Report. Stannett, V.; Stahel, E. P.; Kohler, J.; Oda, E.; Omi, S.; Goineau, A.; Shah, H. P.; Osborne, F. T. (North Carolina State Univ., Raleigh. Dept. of Chemical Engineering). 1 Jun 1971. Contract AT(40-1)-3667. 120p. Dep. NTIS.

Studies were conducted in depth of the radiation-induced polymerization of vinyl monomers under superdry conditions. Basic laboratory studies and engineering pilot plant research were carried out. Results show that neither vinyl chloride nor molten or solutions of trioxane could be induced to polymerize ionically even after the most stringent drying; β pinene was found to polymerize readily after drying; in a study of a series of alpha olefins analogous to isobutylene only isobutylene polymerized ionically; isobutyl vinyl ether was polymerized at the highest yields yet reported; and isopropyl vinyl ether was polymerized under optimum conditions for the first time with a square root dependence of the rate on the dose rate. A recirculating flow reactor system was used to study the radiation-induced polymerization of styrene and α-methylstyrene in bulk and solution. (D.H.M.)

57451 HIGHLY RADIATION-SENSITIVE AMIDES. D'Alelio, Gattano Francis (to PPG Industries, Inc.). British Patent 1,241,622. 4 Aug 1971. Filed 20 Mar 1969.

XUM

Reference is made to amides that are converted to three-dimensional crosslinked, insoluble, and infusible polymers at relatively low radiation doses, such as diacrylyl compounds containing amide groups, and a process is described for producing an improved polyamide resin composition involving treatment of a diacrylylamide with 0.5 to 10 MR of high-energy ionizing radiation of at least 10^5 eV. The diacrylylpolyamide may be admixed with a polyamide resin having a molecular weight of at least 500, or a copolymerisable monomer, or an unsaturated aliphatic alkyd resin. A number of examples are described. (UK)

57452 SYNERGISTIC TREATMENT OF TEXTILE DYE WASTES BY IRRADIATION AND OXIDATION. Craft, T. F.; Eichholz, G. G. (Georgia Inst. of Tech., Atlanta). Int. J. Appl. Radiat. Isotop.; 22: No. 9, 543-7(Sep 1971).

Tests on representative textile dye solutions were performed to compare decoloration effects by treatment with an oxidant, γ radiation, or both. In most cases the combined treatment was much more effective than either alone. The radiation effect was found to be very rapid, with adequate dose rates of the order of 35 to 80 krad and 50 to 100 ppM NaOCl. (auth)

57453 KINETICS OF RADIATION INDUCED SOLID STATE POLYMERIZATION OF TRIOXANE. Rao, M. H.; Rao, K. N. (Bhabha Atomic Research Centre, Trombay, India). Radiat. Eff.; 10: No. 1-2, 87-91(Jul 1971).

The radioinduced polymerization of highly purified trioxane in the solid state was carried out at 56, 51, 46, 31, and 25°C. The polymerization went to completion at all the temperatures studied and the rate of polymerization remained unaltered between 46 to 56°C and 25 to 31°C, but however the rate of polymerization at lower temperature range was half of what was observed at higher temperature range. The rate of polymerization was proportional to the monomer concentration. The polymerization went to completion even with microcrystalline solid and the dose rate exponent was observed to be 0.53. All these results indicate that the defects are not playing any role in the termination reaction. (auth)

57454 EFFECT OF ADDITIVES ON THE RADIOCHEMICAL POLYMERIZATION OF STYRENE IN SOLUTIONS OF CCl_4 OR HEXACHLOROBUTADIENE. Gorzny, K. (Kernforschungsanlage, Juelich, Ger.). Makromol. Chem.; 138: No. 3448, 251-64 (1970). (In German).

The radioinduced polymerization of styrene in solutions of CCl_4 or hexachlorobutadiene at room temperature can be described by a radical mechanism. From the dependence of the relative rate of polymerization on the mole fraction of styrene an energy transfer from styrene to the halogen component is assumed. This transfer, which is caused by a transfer of excitation, is quenched by addition of anthracene, 1,3-pentadiene, and less effectively by p-terphenyl, but is not quenched by addition of naphthalene or anisole. The initiation of polymerization is achieved preferably by radicals formed by the halogen components. Besides this energy transfer a dissociative electron capture producing radicals, which can start the polymerization, occurs. (auth)

57455 KRYPTON DIFLUORIDE. Prusakov, V. N.; Sokolov, V. B. At. Energ. (USSR); 31: No. 3, 259-68(Sep 1971). (In Russian).

Data on krypton difluoride published up to the beginning of 1971 are reviewed. This simple compound of krypton is prepared by passing electrical discharge through a mixture of the elements at a low temperature (–183 to 196°C) and a low pressure (20 to 40 mm) or by irradiation of a mixture of krypton and fluorine with 1.5-MeV electrons and 10-MeV protons. The physical and chemical properties of krypton difluoride are reviewed. KrF_2 differs markedly from xenon fluorides by its higher chemical reactivity. Krypton difluoride would be anticipated to be a fluorine ion donor, but it yields to the xenon difluoride and xenon hexafluoride in this respect. The experimental and theoretical studies of the bonding in krypton difluoride are reviewed. (auth)

57456 INVESTIGATION OF THE POLYMERS FORMED IN REACTOR IRRADIATED BENZENE OR TOLUENE TOGETHER WITH AlN. Barakat, M. F.; Abdel-Kerim, Fawzi M. (Atomic Energy Establishment, Cairo). J. Inorg. Nucl. Chem.; 33: No. 8, 2301-9(Aug 1971).

Studies of recoil carbon atoms in organic media revealed the preferential location of activity in the polymeric products. The polymers formed in neutron-irradiated benzene or toluene, mixed with AlN for carbon recoil generation, were separated and analyzed. Gas chromatographic analysis showed that polymerization of irradiated benzene, either in the presence or absence of AlN, occurred to the same extent indicating that the process is mainly a radiation effect. In toluene the recoil events were found to have a remarkable effect on the polymerization. The ir spectra of the polymers were compared with those of the pure parent compounds. The spectra showed that the polymers have polystyrene-like structures. Marked similarity with the known polystyrene ir spectrum was observed. The preferential location of the activity in the polymers was attributed to the formation of easily polymerizable entities through both the primary attack of carbon recoils on C—H or C—C bonds of the matrix molecules and also hydrogen abstraction by energetic recoils to form reactive $^{14}CH_2$·· radicals. Possible mechanisms of formation of the different polymers were suggested. (auth)

Radiolysis

Refer also to abstract 57930.

57457 (ARH–2163) RADIOLYSIS OF CITRIC ACID SOLUTION. Edvalson, Lars E. (Atlantic Richfield Hanford Co., Richland, Wash.). 1 Aug 1971. Contract AT(45-1)-2130. 13p. Dep. NTIS.

Radiolysis of citric acid in solutions of HNO_3–$Sr(NO_3)_2$ by a cobalt-60 gamma source has a G value of 0.80. For each mole of citric acid destroyed, an average of 7.00 moles of hydrogen ion disappear. Concentrations of citric acid and nitric acid at which dark brown radiolysis products and/or solids formed were also determined. (auth)

57458 (COO–1116-17) [KINETICS OF IONIZING-RADIATION INDUCED REACTIONS IN ORGANIC COMPOUNDS]. Progress Report, December 1, 1970–November 30, 1971. Firestone, F. R. (Ohio State Univ., Columbus. Dept. of Chemistry). Contract AT(11-1)-1116. 69p. Dep. NTIS.

Results of a study of the absorption spectra and kinetics of decay of transient species formed upon the pulsed irradiation of n-pentane, aqueous solutions of n-pentane, and oxygenated n-pentane are reported. The kinetics of decay are interpreted in terms of a model describing the effects of diffusion upon reactions in solution. (D.H.M.)

57459 (DP–1264) RADIOLYSIS OF LIQUID WASTE DURING BEDROCK STORAGE. Bradley, R. F. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug 1971. Contract AT(07-2)-1. 24p. Dep. NTIS.

A proposed method for long-term containment of radioactive wastes produced at the Savannah River Plant is storage in vaults excavated in crystalline rock 1500 ft beneath the surface of the plant. Radiolysis of the waste to form gases will occur during storage of the waste. Tests with synthetic wastes to develop design data on the radiolytic gas evolution rates are summarized. These tests showed that a vapor volume of ~15% of the total sealed volume would be sufficient to keep the pressure in the storage vault below the surrounding 1500-ft hydrostatic pressure. These tests also provide part of the basic data necessary to predict the behavior of the gases and the liquid waste over the ~1000 years of storage necessary for the decay of ^{90}Sr and ^{137}Cs to innocuous levels. (auth)

57460 CHARGE EXCHANGE AND TRANSITION REACTIONS OF A HYDROGEN ATOM DURING COLLISIONS OF ARGON IONS WITH WATER MOLECULES. Arifov, U. A.; Pozharov, S. L.; Chernov, I. G. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 49-52(1971). (In Russian).

The results of a mass spectrometric study of an ion-molecule reaction to form H_3O^+ are given. A mixture of Ar and H_2O vapor (10 to 40 torr) were irradiated with β particles from a Zr–T source of about 30 μCi. An eleven-step series of reactions is proposed to illustrate the mechanism, ending with H_3O^+. The effect of the pressure on this mechanism was investigated. (K.S.W.).

57461 γ-RADIOLYSIS OF GASEOUS CARBON DIOXIDE AT HIGH DENSITIES. Yoshimura, M.; Chosa, M.; Soma, Y.; Nishikawa, M. (Tokyo Univ.). J. Chem. Soc., D; No. 16, 980-1(25 Aug 1971).

G(CO) from γ-irradiated gaseous carbon dioxide at 50 ± 1°C showed a marked increase with density increase above 0.2 g/ml, owing to the increased probability of geminate recombination of ion pairs at high densities. (auth)

57462 EFFICIENCY OF SOME ANTIOXIDANTS IN THE THERMOOXIDATIVE DEGRADATION OF IRRADIATED POLYETHYLENE. Yanson, I. R.; Karlivan, V. P.; Kal'kis, V. Ya.; Rayave, E. L. (Inst. of Physics, Riga). Modif. Polim. Mater.; No. 2, 107-10(1969). (In Russian).

The thermostabilizing effect of several antioxidants on low-density polyethylene was investigated by incorporating the agents into polyethylene on heated rollers and then exposing them to gamma radiation. The antioxidants tested were: 2,2′-thio-bis-(6-tributyl-p-cresol)(CaO-6), tri-(2-methyl-4-oxy-5-tributylphenyl)-butane (Topanol CA), o-oxyphenylazodimedone, and dilaurylthiodipropionate. As a reference standard the compounds di-β-naphthyl-p-phenylenediamine was made a part of the testing program. Concentrations of these additives in the polyethylene were 0.5, 1.2, and 5%. A beneficial effect in stabilizing irradiated polyethylene against heat was observed for the phenolic antioxidants CaO-6 and Topanol CA, the optimal concentration being about 2%. A significant radiation-protective effect was noted for CaO-6. (K.S.W.)

57463 LIGHT EMISSION FROM GAMMA-IRRADIATED ALKANE GLASSES CONTAINING OLEFINS. Brocklehurst, B.; Robinson, J. S. (Univ. of Sheffield, Eng.). Chem. Phys. Lett.; 10: No. 3, 277-9(1 Aug 1971).

After gamma radiolysis at 77°K, glassy alkanes emit weakly in the visible on warming. The similar but stronger emission from dilute olefin solutions suggests that the alkane luminescence is due to radiolysis products. The nature of the emitters is discussed: it is concluded tentatively that they are olefins in twisted excited states formed by recombination of olefin cations. (auth)

57464 ROLE OF THE EXTERNAL SURFACE OF CRYSTALLINE ALKALI HALIDES IN RADIATION INDUCED CHEMICAL DECOMPOSITION. Sugier, H. (Technical Univ., Lodz, Poland). Radiochem. Radioanal. Lett.; 7: No. 5-6, 303-4(10 Sep 1971).

57465 RADICALS IN γ-IRRADIATED HYDRATES OF CYCLIC ETHERS. Trofimov, V. I.; Chkheidze, I. I. (Inst. of Chemical Physics, Moscow). Dokl. Akad, Nauk SSSR; 198: No. 2, 354-7 (11 May 1971). (In Russian).

Cyclic ethers are known to form clathrate compounds with water. The hydrates of the two cyclic ethers, tetrahydrofuran C_4H_8O (THF) and 1,3-dioxolane, $C_3H_6O_2$ (DO), were irradiated with ^{60}Co gamma radiation at 77°K, and the electron paramagnetic resonance (EPR) spectra at different temperatures were determined. These EPR spectra are compared with those of pure ice and pure THF and DO, and the structures of possible free radicals and the locations of an unpaired electron are examined. (K.S.W.)

57466 TRANSIENT SPECIES IN THE PULSE RADIOLYSIS OF PERIODATE ION IN NEUTRAL AQUEOUS SOLUTIONS. Barat, F.; Gilles, L.; Hickel, B.; Lesigne, B. (CEN de Saclay, Gif-sur-Yevette, France). J. Chem. Soc., D: No. 15, 847-8 (11 Aug 1971).

IO_4^{2-} (ϵ_{360} ca. 1000 M^{-1} cm^{-1}) ions and $IO_4^{\cdot}$ ϵ_{520} ca. 3000 M^{-1} cm^{-1}) radicals are formed by pulse radiolysis of periodate ion in aqueous solution. (auth)

57467 INITIAL FATE OF HYDROGEN ATOMS AND HYDROXYL RADICALS IN THE RADIOLYSIS OF FROZEN AQUEOUS SOLUTIONS OF ALKALI HALIDES. Ginns, I. S.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., D; No. 16, 949-50 (25 Aug 1971).

After exposure to ^{60}Co γ-rays, aqueous glasses containing sodium or potassium fluoride, chloride, bromide, or iodide gave ESR spectra containing features characteristic of the radicals $H\cdot$, MH^+, $\cdot OH$, and $halOH^-$. (auth)

57468 OPTICAL MEASUREMENTS ON SOLVATED ELECTRONS IN PULSE-IRRADIATED LIQUID PROPANE. Gillis, H. A.; Klassen, N. V.; Teather, G. G.; Lokan, K. H. (National Research Council of Canada, Ottawa). Chem. Phys. Lett.; 10: No. 4, 481-3(15 Aug 1971).

A broad absorption spectrum with $\lambda_{max} \geq 2000$ nm has been observed in pulse-irradiated liquid propane at low temperatures and assigned to the solvated electron. The electron decays by geminate recombination with an initial half-life of ≤95 nsec at −185°C. (auth)

57469 RADIOLYSIS OF BENZENE VAPOUR BY LOW-ENERGY HEAVY IONS. Olsen, K. J. (Aarhus Univ., Denmark). Trans. Faraday Soc.; 67: No. 583, 2050-6(Jul 1971).

Radiolysis of benzene vapor was studied using 60-keV Ne^+, Ar^+, Kr^+, Xe^+, and Pb^+ ion beams from an electromagnetic isotope separator. Radiolytic products were investigated both directly by emission spectroscopy and indirectly with ESR spectroscopy and chemical analysis of the deposits formed by condensing the irradiated vapor. H atoms were detected in the gas phase, C_6H_5 and C_6H_7 in the condensate. No products were detected after dissolution of the condensates. Results from irradiation of C_6H_5D vapor indicate that all H atoms in the phenyl radical are equivalent with a hyperfine coupling constant of 4.1 G. The ratio between C_6H_5 and C_6H_7 increases with increasing mass of the radiolyzing ion. Relative and absolute cross-sections for production of radicals with the ions mentioned above are compared with theoretical calculations for the reaction $C_6H_6 + \text{ion} \rightarrow C_6H_5 + H + \text{ion}$. (auth)

57470 ELECTRON PARAMAGNETIC RESONANCE OF ELECTRON-IRRADIATED AMMONIA LAYERS. Beuermann, G. Univ., Goettingen, Ger.). Z; Phys.; 247: No. 1, 25-31(1971). (In German).

Ammonia, NH_3 or ND_3, is vaporized upon a cold substrate (20 to 100°K) and irradiated with electrons of energies from 0.2 to 6 keV. The different EPR spectra show hyperfine structure and may be ascribed to centers of the type H_2^-, D_2^-, $(NH_2^-)^-$, $(ND_2^-)^-$. With respect to electrostatic charge a chemical decomposition of ammonia must be assumed. No electronic centers are found that could be compared with the solvated electrons known in liquid metal–ammonia solutions or quenched solid metal–ammonia layers. (auth)

57471 ESR STUDY OF GAMMA-IRRADIATED SINGLE CRYSTALS OF POTASSIUM BICARBONATE AT 77°K. Holmberg, Robert W. (Oak Ridge National Lab., Tenn.). J. Chem. Phys.; 55: No. 4, 1730-5(15 Aug 1971).

Several paramagnetic centers are formed when single crystals of $KHCO_3$ or $KDCO_3$ are gamma-irradiated at 77°K. Their magnetic properties were studied using electron spin resonance. The two centers formed predominantly were identified as the free radicals $(HCO_3)_2^-$. and $\dot{C}O_3^{2-}$. Lesser amounts of HCO_3. were found trapped in two different sites in the crystal. When the crystals are warmed to room temperature (or when irradiated at room temperature), another radical with properties like CO_2^- is formed. (auth)

57472 EFFECT OF THALLOUS IONS ON THE YIELDS OF HYDROGEN AND HYDROGEN PEROXIDE IN RADIOLYZED AQUEOUS SOLUTIONS. Faraggi, M. (Nuclear Research Center, Negev, Israel); Zehavi, D.; Anbar, M. Trans. Faraday Soc.; 67: No. 583, 2057-67(Jul 1971).

The radiolysis of Tl_2SO_4 in neutral and in 0.8 N H_2SO_4 aqueous solutions in the presence and absence of air was investigated. In the absence of air and with low doses of radiation, a steady-state concentration of H_2O_2 is observed. In air-saturated solutions $G(H_2O_2)$ decreases with Tl^+ concentration. The effect of Tl^+ on $G_{H_2O_2}$ was measured by two independent methods, following $G(H_2O_2)$ in aerated solutions and by measuring $G(H_2O_2^{18,18})$ formed in H_2O^{18} in the presence of $H_2O_2^{16,16}$ as protective additive. In neutral and acid solutions, $G(H_2) = G_{H_2} = 0.42 \pm 0.02$, which was independent of Tl^+ concentration. The relatively high efficiency of Tl^+ for scavenging the precursor of H_2O_2 is discussed and compared with that of other reactants known to diminish $G_{H_2O_2}$. The mode of formation of the "molecular" products in the radiolysis of water is discussed in the light of the findings. (auth)

57473 MECHANISM OF THE RADIOLYSIS OF CYCLOHEXANE. Herler, Horst (Technische Univ., Munich). Angew. Chem. Int. Ed. Engl.; 10: No. 6, 420-1(Jun 1971).

The three main products of the radiolysis of cyclohexane (hydrogen, cyclohexene, and bicyclohexene) are formed by rupture of C—H bonds. Absorption of ionizing radiation leads to excited and ionized cyclohexane molecules and to electrons. Amounts of the main products of radiolysis of cyclohexane are increased by addition of small quantities of organic compounds such as benzene, anthracene, and pyrene; the amounts of all three products are maximal at ca. 10^{-4} mole of aromatic compound per liter. Studies using electron scavengers indicate that the probability of ion–electron recombination is about 0.7 if that for ion–molecule reactions is set at 1. (J.G.B.)

57474 GAMMA RADIOLYSIS OF GASEOUS ETHYLENE IN THE PRESENCE OF ISOBUTYLENE. Niedzielski, J.; Gawlowski, J. (Univ. of Warsaw). Radiat. Eff.; 10: No. 1-2, 1-7(Jul 1971).

The effective consumption of isobutylene added to gamma-irradiated ethylene was attributed to ion-molecule reactions. Approximately 4 molecules of isobutylene were used per ion pair (for 0.2 % vol of isobutylene in ethylene). The neutralization of ions, having isobutylene molecules inserted, did not yield hydrogen atoms, as evidenced by the depression in the yields of normal paraffins. In the absence of isobutylene the yield of H atoms from the neutralization of ions was approximately 0.6 G_{ion}. The formation of isobutane, due to the presence of isobutylene, was attributed mainly to two distinct ion-molecule reactions. (auth)

57475 RATE CONSTANTS OF REACTIONS OF PHOTOGENERATED SOLVATED ELECTRONS WITH MONOMERS. Moorthy, P. N.; Kumar, Vijay; Rao, K. N.; Shankar, J. (Bhabha Atomic Research Centre, Trombay, India). Radiat. Eff.; 10: No. 1-2, 129-31(Jul 1971).

The reaction rate constants of solvated electrons were measured in a flash photolysis apparatus for the following monomers: acrylonitrile, methyl acrylate, ethyl acrylate, methyl methacrylate, vinyl isobutyl ether, N-vinylpyrrolidone, vinyl acetate, vinyl benzoate, methacrylic acid, acrylamide, s-trioxane, ethylene, and styrene. The nonvinylic monomers are rather unreactive, but conjugation of the ethylenic double bond with the benzene ring, carbonyl, or cyano group results in high reactivity. (D.L.C.)

57476 RADICALS OF THE γ-IRRADIATED HYDRATES OF THE THREE-MEMBERED CYCLES. Trofimov, V. I.; Blumenfeld, A. L.; Kostyanovskii, R. G.; Chkheidze, I. I. (Inst. of Chemical Physics, Moscow). Tetrahedron Lett.; No. 35, 3267-70(Aug 1971).

The striking increase in stability of the radicals formed by γ-irradiation of clathrate hydrates of cyclopropane, ethylene oxide, and propylene oxide is reported. (auth)

57477 RADIOLYTIC FORMATION OF LONG-LIVED AMMONIATED ELECTRONS AT ROOM TEMPERATURE. Belloni, J.; de la Renaudiere, J. F. (Faculte des Sciences, Orsay, France). Nature (London) Phys. Sci.; 232: No. 34, 173-4(23 Aug 1971).

The γ radiolysis of a 5×10^{-2}M solution of KNH_2 and hydrogen at pressures from 0.2 to 0.8 atm was studied in order to clarify the mechanism for the production of e^-_{m}. Absorbance in the visible and near infrared was recorded before and after irradiation, the slow post-irradiation decay being accelerated by contacting the solution with Pt foil. Results indicate the formation of a species with properties similar to those of solvated electrons from metal–ammonia solutions, provided that the disappearance reactions of e_{am} with NH_2 radicals and NH_4^+ ions are prevented. (J.G.B.)

57478 RADIOLYSIS OF PETROLEUM PRODUCTS. Reyes Lujan, Javier (Comision Nacional de Energia Nuclear, Mexico City. Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis.; 19: FA1-40(1970). (In Spanish).

The advances made in the area of radiolysis of petroleum products are reviewed. The radiation cracking of crude petroleum and the combination of radiation with the conventional thermal or catalytic cracking procedures are discussed. The radiation treatment of various fractions of petroleum or refined products in order to obtain products with special properties that are unobtainable with conventional procedures is considered. The radiation treatment of residual products of normal refining in order to obtain new useful products is discussed. (J.S.R.)

Radioisotope Production

Refer also to abstracts 57352, 57521, and 57559.

57479 (BMBW-FBK-71-6) CALCULATIONS FOR PRODUCTION OF ^{231}Pa AND ^{232}U BY NEUTRON IRRADIATION FROM ^{230}Th AND ^{232}Th MIXTURES IN THE REACTOR WITH VARIOUS IRRADIATION CONDITIONS. Kim, J. I.; Gueckel, W. (Technische Hochschule, Munich (West Germany). Institut fuer Radiochemie). Jun 1971. 264p. (In German). Dep. NTIS (U. S. Sales Only).

Calculations were made for production of ^{231}Pa and ^{232}U by reactor neutron irradiation of thorium–ionium mixtures. The production yields of all transmuted nuclides in the system were calculated with respect to all irradiation conditions available from thermal reactors. The resonance flux was also included in the calculations. From results the buildup patterns of ^{231}Pa and ^{232}U are demonstrated and some examples of production schemes prepared. Discussions are made on the effective irradiation conditions, the efficacity of production, the dilution of ^{232}U in total uranium, and the irradiation of thorium with low ionium concentration. (auth)

57480 (JINR-P6-5955) FAST THERMOCHEMICAL METHODS OF SEPARATION OF RADIOACTIVE ELEMENTS. I. PRODUCTION OF THE RADIOACTIVE Re ISOTOPES. Bayar, B.; Zaitseva, N. G.; Novgorodova, A. F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

On the basis of the thermochemical properties of Re oxides a fast gas thermochromatographic method was developed for separation of Re from the complex mixture of products produced by bombarding NH_4ReO_4 and OS_{met} targets with high-energy protons. This method allows radioactive samples of Re to be obtained for studying of nuclear-spectroscopic properties of short-lived isotopes with a half-life of several minutes. (auth)

57481 (KURRI-TR-76, pp 8-14) CHEMICAL SEPARATION IN AN ISOTOPE SEPARATION ON-LINE (ISOL) SYSTEM. Kume, Sanshiro (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on nuclei with short life; Osaka, Japan (30 Jun 1969).

In Reports of the study meeting on nuclei with short life.

Super-fast chemistry for the study of short-lived nuclei far off beta stability line is discussed. Objective nuclides are produced by reaction through highly excited compound nuclei, and various other nuclides are produced simultaneously. The nuclide, therefore, must be separated chemically from the others, and mass separation with an isotope separator on-line (ISOL) is carried out. This chemical separation should be performed within a very short time because of short lifetime of the nuclei produced. Main processes of the separation are extraction of the nuclides from a target, transportation, chemical separation, and ionization as ion source of the mass separator. Two methods are considered for the extraction. The one is a diffusion-evaporation method. The nuclides come out from the target by the diffusion process. The target is usually maintained at high temperature. The other method is the recoil method. The nuclides come from the target with the aid of recoil energy. The extraction time is negligibly short. The flight path of the recoiling ions, however, is short; and the target should be thin. The transportation of the nuclides is performed by flowing carrier gas such as nitrogen or helium. Sometimes, some element is removed during the transportation by the use of condensation process. The super-fast chemistry is very important in the ISOL system, but still a method for selective separation is not established. Wet methods may be impossible within a very short time. Dry methods were tried. For example, the nuclei in the carrier gas are contacted with reaction material until chemical equilibrium is reached. Hot-atom chemistry is also used for the chemical separation. A table of ISOL systems currently in use throughout the world is presented. (Japan)

57482 (ORNL-tr-2535) ELAN-2B, PILOT PLANT FOR ^{137}Cs AND ^{90}Sr SOURCES. Prevotel, Marc. Translated by Martha Gerrard (Oak Ridge National Lab., Tenn.), from Ind. At.; 14: No. 9/10, 41-6(1970). 7p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 23633.

57483 PREPARATION OF ^{99m}Tc BY DIRECT ADSORPTION FROM ORGANIC SOLUTION. Tachimori, Syoichi; Amano, Hiroshi; Nakamura, Haruto (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: No. 7, 357-62 (Jul 1971).

Purification of ^{99m}Tc extracted into methyl ethyl ketone from an alkaline solution of neutron-irradiated MoO_3 was studied in order to establish a rapid method for producing ^{99m}Tc. After removal of the organic solvent by evaporation, ^{99m}Tc could be purified from remaining traces of Mo and other contaminants by adsorption in an alumina column from an aqueous solution and by subsequent elution with 0.1N HCl or with physiological saline solution. Organic solvents containing ^{99m}Tc could also be treated directly in an alumina column to purify the ^{99m}Tc. This method saved the time required for the evaporation of the solvent. Problems essential to the adsorption of ^{99m}Tc on alumina in organic media were studied to determine the optimum conditions for the adsorption. A standard procedure for ^{99m}Tc preparation would consist of extraction of the ^{99m}Tc into methyl ethyl ketone from alkaline solution, passing the organic phase through a cation exchange column to remove Na and then through an alumina column, and finally, elution of ^{99m}Tc from alumina column with 0.1N HCl or saline solution. The process can be finished within 1 hr. About 500 mCi of ^{99m}Tc is obtained with a chemical yield higher than 95%, and the product contains less than 10^{-4}% of radiochemical impurities. (auth)

57484 GENERATOR SUBSTANCE FOR PRODUCING RADIOACTIVE ^{137m}Ba. Bernhard, Horst; Lieser, Karl-Heinrich (to EURATOM). British Patent 1,242,159. 11 Aug 1971. Priority date 12 Dec 1968, Germany.

A method for prolonging the life of a ^{137}Cs generator for the production of ^{137m}Ba is proposed. Contamination of the desired product or loss of ^{137}Cs by successive milking operations is reduced by the use of a carrier or framework substance consisting of iron or steel, the surface of which is coated with a thin layer of iron ferrocyanide to which the ^{137}Cs is fixed. The generator, which has a practically unlimited life, can be eluted rapidly and produces ^{137m}Ba with a decontamination factor of more than 10^6. (J.G.B.)

57485 METHOD OF PRODUCING GASEOUS NUCLIDES. Schmeling, Per Erik (to Aktiebolaget Atomenergi). British Patent 1,242,450. 11 Aug 1971. Filed 8 Nov 1968.

A method is described for the production of gaseous radionuclides from neutron-irradiated target materials, such as ^{133}Xe from irradiated U; it is claimed to be less complicated and more reliable than some other methods in use, and to be suitable for commercial production. It comprises melting the target material with a fluxing agent to produce a comparatively low-melting fluxed target, enclosing this target in a gas-tight container, and irradiating in a nuclear reactor. The container and contents are then heated until the contents are molten, thus releasing the gaseous nuclides, followed by placing the gaseous phase in communication with a suitable gas-recovery apparatus, which may consist of a closed evacuated system containing an appropriate adsorption agent. An example of a suitable fluxed U target is the mixture of molten salts produced by dissolving UO_2 in molten sodium pyrosulphate; this has a melting point of 500° to 600°C, is readily soluble in water, and can achieve 30% by weight of U. A liquid-nitrogen-cooled carbon trap may be used in the adsorption system, giving nearly pure ^{133}Xe on desorption. (UK)

57486 ^{52}Fe: IMPROVING ITS RECOVERY FROM CYCLOTRON TARGETS. Thakur, M. L.; Nunn, A. D.; Waters, S. L. (Hammersmith Hospital, London). Int. J. Appl. Radiat. Isotop.; 22: No. 8, 481-3(Aug 1971).

Previous methods of recovering ^{52}Fe from cyclotron targets and their shortcomings are briefly reviewed. A modified chromium target system and a simplified solvent extraction method, for which >98% ^{52} Fe recovery is ensured, are described. The advantages of this method are noted and variations in the extraction technique, with their retrieval percentages, explained. Higher extraction efficiency results after boiling the etch solution, and possible reasons for this are discussed. Use of a 15-cc Ge(Li) detector to assess the efficiency of individual steps is noted. (UK)

Recoil Production and Reactions

Refer also to abstracts 57456, 57501, and 57503.

57487 (COO-1713-25) REACTION STUDIES OF HOT SILICON AND GERMANIUM RADICALS. Progress Report, September 1, 1970–August 31, 1971. Gaspar, Peter Paul (Washington Univ., St. Louis, Mo. Dept. of Chemistry). Contract AT(11-1)-1713. 14p. Dep. NTIS.

Research progress is reported on the following topics: product-forming steps in the reactions of recoil silicon atoms, primary reactions of recoiling silicon atoms, reactions of recoiling germanium atoms, and kinetics of silyl radical reactions and flow-discharge production of Si, Ge, and C atoms. (D.H.M.)

57488 CHEMICAL CONSEQUENCES OF THE REACTION $^{238}U(n,\gamma)^{239}U$ IN URANIUM SULFATES AND ACETATES. Heitz, Ch.; Ruffenach, J. C. (Centre de Recherches Nucleaires, Strasbourg). Radiochem. Radioanal. Lett.; 7: No. 5-6, 319-24(10 Sep 1971). (In French).

The oxidation states of ^{239}U formed by the $^{238}U(n,\gamma)$ reaction in uranyl and uranous sulfates and acetates were measured. Effects of secondary oxidation and isotope exchange reactions are discussed. (auth)

57489 EFFECTS OF THERMAL NEUTRON CAPTURE IN PLATINUM ACETYLACETONATE. Belgrave, E. (Centre de Recherches Nucleaires, Strasbourg). Radiochem. Radioanal. Lett.; 7: No. 5-6, 325-9(10 Sep 1971).

A study of the chemical consequences of neutron capture in platinum acetylacetonate revealed an important isotope effect. (auth)

57490 THERMAL ANNEALING AND SOLID STATE ISOTOPE EXCHANGE OF ^{51}Cr IN POTASSIUM TRISOXALATO CHROMATE-(III) TRIHYDRATE. Kishore, K.; Venkateswarlu, K. S. (Bhabha Atomic Research Centre, Trombay, India). Radiochem. Radioanal. Lett.; 7: No. 5-6, 263-8(10 Sep 1971).

Neutron-irradiated potassium trisoxalato chromate(III) trihydrate yields four radioactive species after dissolution. The presence of a ligand-deficient species and the change in its yield on annealing at lower temperatures suggest a stepwise mechanism for the annealing reaction. Doping of the nonirradiated complex with ^{51}Cr and the following of the Cr exchange also indicate the presence of ligand-deficient intermediate species. The exchange reaches about 80%. (auth)

57491 DIFFERENCES BETWEEN THE REACTIONS OF GASEOUS CH_4 WITH ^{80}Br AND ^{82}Br ACTIVATED BY ISOMERIC TRANSITION. Yagi, M.; Kondo, K.; Kobayashi, T. (Tohoku Univ., Sendai). Radiochem. Radioanal. Lett.; 7: No. 5-6, 275-80(10 Sep 1971).

The reactions of ^{80}Br and ^{82}Br, activated by the isomeric transition, with gaseous CH_4 were compared with each other. It was confirmed that the total organic yields in the $CH_4-{}^{80m}BrBr$ system are much higher than those in the $CH_4-{}^{82m}BrBr$ system. This difference is attributed to the consecutive, two-step internal conversion process in the cascade de-excitation of ^{80m}Br. (auth)

57492 DIFFERENCES BETWEEN THE REACTIONS OF GASEOUS CH_3Br WITH ^{80}Br AND ^{82}Br ACTIVATED BY ISOMERIC TRANSITION. Shiokawa, T.; Kobayashi, T.; Kondo, K.; Yagi, M. (Tohoku Univ., Sendai). Radiochem. Radioanal. Lett.; 7: No. 5-6, 281-6(10 Sep 1971).

The reactions of isomeric transition-activated ^{80}Br in the $CH_3Br-{}^{80m}BrBr$ system were compared with those in the $CH_3Br-{}^{82m}BrBr$ system. The organic yields and the highly brominated product yields in the former system were found to be higher than those in the latter system. These facts suggest that there are fundamental differences between the reactions of ^{80}Br and ^{82}Br, activated by the isomeric transition, with gaseous CH_3Br. (auth)

57493 ISOTOPE EXCHANGE AND THERMAL ANNEALING OF RECOIL DAMAGE IN TRISOXINATOCOBALT(III). Venkateswarlu, K. S.; Anthony, M. C.; Ramshesh, V. (Bhabha Atomic Research Centre, Trombay, India). Radiochem. Radioanal. Lett.; 7: No. 5-6, 259-62(10 Sep 1971).

Trisoxinatocobalt(III) was investigated for thermal annealing following neutron capture, and for isotope exchange with $^{58}Co^{2+}$, both in the presence and absence of oxygen. (auth)

57494 $^{80m}Br/I.T./^{80}Br$ REACTIONS IN INORGANIC BROMIDE–HYDROCARBON SYSTEMS. I. VARIATION OF THE ORGANIC YIELD WITH THE INORGANIC BROMIDE. Mohan, H.; Iyer, R. M. (Bhabha Atomic Research Centre, Trombay, India). Radiochem. Radioanal. Lett.; 7: No. 5-6, 381-5(10 Sep 1971).

If ^{80m}Br present as NH_4Br, $MgBr_2$, $CaBr_2$, $ZnBr_2$, $SrBr_2$ or $HgBr_2$ undergoes isomeric transition reactions in n-hexane, the observed organic yields do not follow the trend expected from differences in kinetic energy of the ejected ^{80}Br. It was concluded that the resultant positive charge on ^{80}Br at the time of its break from its original partner determines the final chemical stabilization of the radioactive atom. (auth)

57495 HOT-ATOM CHEMISTRY OF POLYPHOSPHATES. IV. RADIATION EFFECT ON THE OXIDATION STATE OF ^{32}P IN AQUEOUS PHASE. Matsuura, Niro; Lin, Tsing-ko (Tokyo Univ.). J. Inorg. Nucl. Chem.; 33: No. 8, 2281-9(Aug 1971).

Tripolyphosphate solution with various scavengers such as phosphite, hypophosphite, formate, and benzene was irradiated in the reactor. The radioactive yields of hypophosphite (^1P), phosphite (^3P), and phosphate (^5P) as well as diphosphite ($^2P-{}^4P$) and hypophosphate ($^4P-{}^4P$) depended on the irradiation time and the scavenger used. The recoil ^{32}P species that had a mean oxidation state of +2 at zero γ-dose were mainly composed of ^1P and ^3P species; however, both H and OH radicals produced from the γ radiolysis of water oxidized ^1P to ^3P and ^3P to ^5P through the intermediate states of ^2P and ^4P, respectively. On the basis of these observations, the reaction mechanism of ^{32}P in the aqueous phase was also discussed. (auth)

57496 TRANSFER ANNEALING IN CHROMIUM(III) TRISACETYLACETONE. Gainar, I.; Ponta, A. (Inst. for Atomic Physics, Bucharest). J. Inorg. Nucl. Chem.; 33: No. 8, 2291-2300(Aug 1971).

A comparative study of the thermal transfer, or exchange, in $^{51}Cr(III)$-doped chromium trisacetylacetone crystals and the thermal annealing in the neutron-irradiated crystals was carried out. Quite different thermal behaviors were found in the case of Cr. $acac_3$-crystals, doped with the ^{51}Cr species present in a methanolic solution of $^{51}CrCl_3$ and the undoped crystals. The thermal transfer in Cr. $acac_3$ crystals doped with the ^{51}Cr species present in a methanolic fraction obtained as a recoil product was quite similar to the thermal annealing in the neutron-irradiated crystals. A ligand transfer mechanism is suggested to account for such behavior. (auth)

57497 BEHAVIOR OF RADIOACTIVE RHENIUM ATOMS IN THE THERMAL ANNEALING OF CRYSTALLINE RHENIUM SALTS, IRRADIATED WITH 660 MeV PROTONS. Zaitseva, N. G.; Ianovich, E. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 103-7(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 107-13(Jan-Feb 1971).

The influence of thermal annealing on the chemical behavior of rhenium recoil nuclei, formed in the irradiation of sodium perrhenate and potassium hexachlororhenate crystals with 660-MeV protons, was studied. The behavior of radioactive rhenium depends on the chemical form of the irradiated compound: competing reactions of reduction and oxidation take place in $NaReO_4$ crystals, while processes of reduction of rhenium corresponding to the classical shape of the isothermal annealing curves take place in K_2ReCl_6 crystals (the fast step of the reduction of radiorhenium and a slower step with pseudoplateau). On the basis of the results of a kinetic investigation of the thermal annealing of K_2ReCl_6 crystals, the rate of reduction of radioactive rhenium, activation energy, and order of the reaction were determined for the

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fast step of the process. The behavior of radiorhenium in the thermal annealing of K_2ReCl_6 crystals, irradiated with 660-MeV protons and thermal neutrons, is the same, which is an indication of independence from the recoil energy. The mechanism of the behavior of radioactive rhenium atoms in thermal annealing is discussed from the standpoint of the interaction of recoil atoms with defects of the lattice of the irradiated crystals. (auth)

Radiochemistry

Refer also to abstracts 57297, 57365, 57442, 57491, 57492, 57494, and 58047.

57498 (CONF-711002–, pp 283-92) SAMPLING AND DILUTION PROBLEMS IN RADIOACTIVITY MEASUREMENTS. van der Eijk, W.; Vaninbroukx, R. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Techniques for achieving minimal errors introduced by dilution and sampling in the preparation of radioactivity standards are discussed. The two techniques employed at the Central Bureau of Nuclear Measurements in Geel, Belgium, namely gravimetric and volumetric methods, are discussed. Stability of solutions and sources are also considered. It was concluded that in the calibration of radioactive solutions, errors due to sampling and dilutions can be kept below 0.03% for drop masses of about 100 mg and below 0.07% for drop masses of about 20 mg, provided that the weights can be calibrated with sufficient accuracy. (D.H.M.)

57499 FORMATION OF IODIDES IN SOLID BUTANE IRRADIATED BY I^+ IONS. Cailleret, J.; Abbe, J. Ch.; Paulus, J. M. (Centre de Recherches Nucleaires, Strasbourg). Radiochem. Radioanal. Lett.; 7: No. 5-6, 331-7(10 Sep 1971). (In French).

An ion generator was built in order to study the reactions of a solid butane target with 3000- to 50-eV I^+ beams. The analysis is performed by gas chromatography and the following products are generated: ICH_3, IC_2H_5, n-IC_3H_7, s-IC_4H_9, n-IC_4H_9. The organic yields and the distribution are energy dependent. (auth)

57500 FAST PREPARATION METHOD OF ^{32}P APPLICATORS. Svobodova, J. (Vyzkumny Ustav pro Vyuziti Radioisotopy v Lekarstvi, Prague); Kolinska, J.; Kronrad, L. Radioisotopy; 11: No. 3, 447-56(1970). (In Czech).

A fast and simple preparation method of ^{32}P applicators for clinical use was developed. The applicators are made by sorption of ^{32}P-labeled sodium phosphate ^{32}P-labeled phosphoric acid on Anex foil Zerolith FF. The detailed experimental procedure and sorption conditions are described. (auth)

57501 SOME EXPERIMENTAL DATA CONFLICTING WITH THE EXPLOSION MODEL IN GASEOUS BROMIDES. Takita, Y.; Hiraga, M.; Yoshihara, M.; Shiokawa, T. (Tohoku Univ., Sendai). Radiochem. Radioanal. Lett.; 7: No. 5-6, 313-18(10 Sep 1971).

Some experimental results that qualitatively conflict with the "explosion model" proposed by Carlson and White were obtained in the x-ray irradiation of gaseous bromides and in the isomeric transition of ^{80m}Br-labeled methyl bromide. The hydrogen-deficient species, such as CH_2Br^+, $CHBr^+$, and CBr^+, were detected in addition to the parent ion CH_3Br^+ after the isomeric transition. Limitations of the "explosion model" are discussed. (auth)

57502 DEVICE FOR THE SAFE HANDLING OF TRITIUM GAS. den Hollander, W. (Vrije Univ., Amsterdam). Radiochem. Radioanal. Lett.; 7: No. 5-6, 345-50(10 Sep 1971).

A device for tritium handling is described, which has three distinct advantages: (1) Tritium gas is stored as uranium tritide behind a palladium diffusion tube in a completely sealed vessel. The palladium tube ensures chemical purity of the tritium gas. (2) A specially designed gas burette is connected to the storage vessel. The amounts of gas can be determined before and after use. (3) Tritium gas is transferred from gas burette to reaction vessel and vice versa with the aid of a Toepler pump. The tritium gas in the reaction vessel can be pressurized up to 3 atmospheres. (auth)

57503 CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS IN THE ALKALI CHLORIDES. PART 3. BEHAVIOUR OF ION IMPLANTED ^{35}S. Kasrai, M.; Maddock, A. G.; Freeman, J. H. (Cambridge Univ., Eng.). Trans. Faraday Soc.; 67: No. 583, 2108-16(Jul 1971).

The valence distribution of ion-implanted ^{35}S in sodium chloride was investigated and the influences of pre-bombardment of the crystal with O, S, and Cl measured. The effects of pre- or post-irradiation of the crystals with γ radiation and of thermal annealing combined with these treatments were examined. A small part of the ^{35}S penetrates deeply into the crystal, giving a supertail to the distribution. This phenomenon is attributed to interstitial diffusion and the valence distribution of this sulphur was measured. (auth)

57504 SYSTEM FOR THE PRODUCTION AND STUDY OF BROMINE DELAYED NEUTRON PRECURSORS FROM FISSION. Mitsonias, C. A.; Perricos, D. C. (Democritus Nuclear Research Center, Athens). Radiochim. Acta; 15: No. 4, 187-90(Jun 1971).

A system is described for the fast separation of bromine delayed neutron precursors from fission products, based on gas sweeping of a uranium solution in concentrated sulfuric acid. The system was developed for the study of the delayed neutron energy spectrum by a time-of-flight $\beta-n$ coincidence technique and is fully automated. (auth)

57505 ABSOLUTE ACTIVITY MEASUREMENT OF ^{3}H. Kokta, L.; Kits, J.; Bucina, I.; Novotna, P. (Ustav Pro Vyzkum, Vyrobu a Vyuziti Radioisotopu, Prague). Radioisotopy; 11: No. 5, 953-71(1970). (In Czech).

On the basis of experiences with absolute determination of ^{14}C a method of absolute activity measurement of ^{3}H was proposed and realized. Tritiated water forming the standard solution is reduced with zinc powder in a sealed ampoule at 600°C. The active hydrogen thus formed is completed with methane to atmospheric pressure and after mixing with a Toeppler pump measured by three internal proportional counters of various lengths. The specific activity of the standard solution is determined on the basis of counting rate distribution in two counters with relation to volume difference and corrections are made for the wall effect, discrimination threshold, dead time of the measuring device, background, and conversion efficiency to active gas. The standard deviation from the specific activity established in this way is ±0.53% which corresponds to a maximum error of ±1.6%. (auth)

57506 EVALUATION METHOD OF THE GAMMA SPECTROMETRICAL DETERMINATION OF RADIUM IN STATE OF NONEQUILIBRIUM. Thomas, J.; Malatova, I. (Vyzkumny Ustav Hygieny Zareni, Prague). Radioisotopy; 11: No. 5, 815-21 (1970). (In Czech).

A method of analysis of a time-dependent multicomponent spectrum of radium and its decay products in a state of nonequilibrium is described. The method is based on the multidimensional nonlinear regression spectral analysis leading simultaneously to the determination of the counting efficiency coefficients of the individual components and of their activities. In routine measurements of the preparation under identical measurement conditions it is possible to apply once for ever the determined measurement coefficients and to determine the activity of the spectrum components by linear multidimensional regression analysis. The method of simultaneous determination of detection coefficients in initial activities described is applicable to mixtures with time to variable activities. (auth)

Separation Processes

Refer also to abstracts 57343, 57352, 57398, 57459, 57481, 57623, 57666, 57900, 58351, and 59904.

57507 (ANL-7799) CHEMICAL ENGINEERING DIVISION FUEL CYCLE TECHNOLOGY QUARTERLY REPORT, JANUARY–MARCH 1971. Webster, D. S.; Jonke, A. A.; Bernstein, G. J.; Levitz, N. M.; Pierce, R. D.; Steindler, M. J.; Vogel, R. C. (Argonne National Lab., Ill.). Jul 1971. Contract W-31-109-eng-38. 71p. Dep. NTIS.

During the period January through March, 1971, work was done in the following areas: (1) further development of a liquid-metal head-end process for LMFBR fuel by study of the reduction of declad fuel oxide, (2) investigation of a procedure for separating stainless steel cladding from fuel oxide by melting the cladding, (3) additional laboratory-scale work to develop a fluid-bed process for the conversion of uranyl nitrate and plutonium nitrate in nitric acid solutions to an oxide form (UO_2-PuO_2) suitable for the fabrication of fuel shapes for LMFBR fuel, (4) additional development of x-ray diffraction spectrometry as an in-line analytical method for determining the Pu/U ratio of oxide fuels during fabrication, (5) continued investigation of the performance characteristics of a centrifugal contactor for plutonium isolation steps in the solvent extraction of LMFBR fuels, and (6) study of electrode reactions and process parameters that affect the electrolytic reduction and reoxidation of plutonium in the Purex process. (auth)

57508 (ANL–7810) DEVELOPMENT OF A MIXER-SETTLER FOR LIQUID METAL-SALT SYSTEMS. Knighton, J. B.; Bernstein, G. J.; Vargo, G. N.; Pierce, R. D. (Argonne National Lab., Ill.). Jun 1971. Contract W-31-109-eng-38. 49p. Dep. NTIS.

A single-stage mixer-settler was developed for application in a multistage extraction process to extract plutonium from spent LMFBR fuel material. This device is designed to separate plutonium from fission products by salt extraction and salt transport procedures. (Salt transport is selective transfer of a solute from a liquid donor alloy to a liquid acceptor alloy by circulating molten salt between the two alloys.) The design of the unit fabricated provides for contacting of two liquid phases in a mixing chamber by blades on the outside of a hollow agitator-pump rotating in the mixing chamber; the mixture is then pumped through the interior of the mixer-pump to discharge openings at its top, from which the mixture is routed as required for a particular application. Preliminary tests with a 5-cm-OD, 20-cm-long stainless steel mixer-pump showed it to be capable of pumping Mg–Cu alloy at 670°C. However, mixing blades at the bottom of the mixer-pump failed to provide sufficient agitation. A second stainless steel mixer-pump was fabricated. This pump employed a stepped cylindrical wall with mixing blades attached to the outer surface of the pump near its bottom. A mixing chamber design was developed whereby gas entrainment in the mixing chamber was eliminated. In runs with water only, flow rate was related to pump speed, the size of the inlet orifice in the bottom of the pump, and the depth of water on the outside of the pump (pump submergence). The residence time distribution for water flowing through the mixing chamber was also studied. High-temperature runs were performed with the mixer-pump installed in an assembly containing a settling chamber, all within a sealed heated vessel. Metal flow rates were successfully measured with a metering cup and an induction liquid-level probe. To measure extraction efficiency, tagged cerium was extracted from Mg–Cu alloy into chloride salts at 650°C. Stage efficiencies above 99% were achieved. The overall mechanical performance of the single-stage mixer-settler was considered satisfactory. (auth)

57509 (ARH-SA–58) MACRORETICULAR ION EXCHANGE RESIN CLEANUP OF PUREX PROCESS TBP SOLVENT. Schulz, Wallace W. (Atlantic Richfield Hanford Co., Richland, Wash.). 1 Aug 1970. 27p. Dep. NTIS.

This report appeared in rough draft form in NSA 25: 34679 as ARH-SA-58-RD (CONF-710417-2). (D.H.M.)

57510 (ARH-SA–82) CONTROL OF A CONTINUOUS ION EXCHANGE SYSTEM. Hobart, R. L. (Atlantic Richfield Hanford Co., Richland, Wash.). 20 Oct 1970. Contract AT(45-1)-2130. 18p. (CONF-701022–2). Dep. NTIS.

From Regional meeting of the AIChE; Richland, Wash. (23 Oct 1970).

The control system that is necessary to operate the continuous anion exchange equipment used in the purification of plutonium at the Hanford Purex Plant is described, including process description, resin "push" system and controls, absorption-scrub column, elution column, programmer, alpha monitors, and operating history. (D.H.M.)

57511 (BNWL-B–121) DESTRUCTION OF NITROUS ACID AND HYDRAZOIC ACID IN PUREX SYSTEMS. Swanson, J. L. (Battelle Pacific Northwest Labs., Richland, Wash.). Aug 1971. Contract AT(45-1)-1830. 13p. Dep. NTIS.

Most of the hydrazoic acid formed in the Purex process is present in the organic phase until it is removed as azide ion by the carbonate wash in the organic recovery process. Destruction of the azide ion in the carbonate solution can be accomplished by platinum-catalyzed hydrazine reduction. Azide destruction can be accomplished in several ways in acid solution; the most promising method for use at Hanford is the reaction with permanganate following acidification of the mixed permanganate–carbonate solvent wash solution. Elimination of nitrous acid from the organic stream fed to the partition column (the 1BXF solution) would markedly reduce if not eliminate hydrazoic acid formation in the 1BX column. Several ways of accomplishing this were demonstrated; the most promising method for plant application is the reaction with hydroxylamine before the organic stream is fed to the column. (auth)

57512 (DOCKET-50201–87) WEST VALLEY REPROCESSING PLANT. Technical Specifications, Change No. 15. (Division of Materials and Licensing (AEC), Washington, D. C.). 24 Sep 1971. 36p. Dep. NTIS.

The publication "Technical Specifications of License No. CSF-1" was revised to incorporate Technical Specifications related to operation of the main plant and to the low-level liquid waste treatment plant and to discharge of effluents to the watershed. Reporting requirements in connection with operation of the low-level waste treatment plant are listed. Safety evaluations of the waste treatment facility are given. (M.C.G.)

57513 (DOCKET-50201–88) WEST VALLEY REPROCESSING PLANT. Final Safety Analysis Report, Revised Tornado Missile Analysis. (Nuclear Fuel Services, Inc., Rockville, Md.). 23 Sep 1971. 6p. Dep. NTIS.

A revised tornado missile analysis is presented, which uses a pressure drop of 3 psi in 3 sec during tornado passage. (M.C.G.)

57514 (DOCKET-50201–89) WEST VALLEY REPROCESSING PLANT. Addendum to Safety Evaluation for Transfer and Processing of Plutonium Nitrate–Uranyl Nitrate Solutions. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 15 Oct 1971. 5p. Dep. NTIS.

Details of transfer and processing of plutonium nitrate–uranyl nitrate solutions are modified and expanded. Topics covered include: transfer to the dissolver, feed adjustment and accountability, and solvent extraction processing. (M.C.G.)

57515 (DOCKET-50268–15) MIDWEST FUEL RECOVERY PLANT. Amendment No. 18, Supplement No. 1 to Amendment No. 15. (General Electric Co., San Jose, Calif. Nuclear Fuel Dept.). 20 Aug 1971. 38p. (NEDO–10178–4). Dep. NTIS.

Information is presented in support of the request for authorization of activities requiring source, special nuclear, and by-product materials. (M.C.G.)

57516 (DOCKET-50332–20) BARNWELL NUCLEAR FUEL PLANT. Reasons Why the Construction Permit Should Not Be Suspended Pending Supplemental Environmental Review. (Allied-Gulf Nuclear Services, Barnwell, S. C.). 11 Oct 1971. 244p. (EMP–100; EMP–101). Dep. NTIS.

An environmental impact program for the Barnwell Nuclear Fuel Plant and an analysis of the impact of the plant's liquid discharges on Lower Three Runs Creek are presented. Reasons for not suspending the construction permit are listed. (M.C.G.)

57517 (DP–1266) REMOTE DECONTAMINATION OF EQUIPMENT IN A RADIOCHEMICAL SEPARATIONS PLANT. Hill, A. J. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Sep 1971. Contract AT(07-2)-1. 33p. Dep. NTIS.

At the Savannah River Plant, process equipment from the radiochemical separations plants is decontaminated rapidly and economically by scouring with high-velocity jets of water and by applying dilute solutions of simple reagents at elevated temperatures. The decontamination, disassembly, and some maintenance and auxiliary work are done by remote operation to minimize exposure of personnel to radiation. In over five years of operation, this technique made possible the salvage and repair of much valuable equipment and significantly reduced radiation exposure during maintenance work. (auth)

57518 (EURFNR–888) AQUEOUS REPROCESSING OF FAST BREEDER FUEL ELEMENTS. COMMON EXTRACTION AND SEPARATION OF MACROQUANTITIES OF PLUTONIUM AND URANIUM IN THE PUREX PROCESS. Ochsenfeld, W.; Schmieder, H.; Theiss, S. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Translation of report KFK–911. 104p. Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

For the reprocessing of irradiated fast breeder fuel elements by solvent extraction with 20% TBP–alkane, coextraction, cobackwash, and partitioning of uranium and plutonium were studied. In the coextraction and cobackwash countercurrent experiments, losses of plutonium and uranium to the aqueous raffinate (HAW) and to the organic extractant (HCW) remained below 0.1%. Partitioning of plutonium and uranium by reduction with uranium(IV) was studied intensively, and compared with reduction by ferrous sulfamate. Countercurrent experiments resulted in plutonium losses to the uranium stream (1BU) of less than 0.2%, while the decontamination of the plutonium product (1BP) from uranium yielded a decontamination factor of $\sim 10^3$. (auth)

57519 (IN–1484) PROCESS CHEMISTRY FOR BURNER PRODUCT FROM GRAPHITE FUELS CONTAINING NIOBIUM. Paige, B. E.; Evans, T. L. (Idaho Nuclear Corp., Idaho Falls). Jun 1971. Contract AT(10-1)-1230. 32p. Dep. NTIS.

A burn-leach process is being developed for reprocessing Rover rocket fuels at the Idaho Chemical Processing Plant. Data are reported for an aqueous process for recovering uranium from the HNO_3-soluble oxide in the burner product and also from the HNO_3-insoluble uranium, Nb_3UO_{10}, which forms during combustion. Dissolution rates of Nb_3UO_{10} and of Nb_2O_5 from overhead product increased with increasing fluoride concentration both for various concentrations of hydrofluoric acid and for mixtures of hydro-

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fluoric acid–nitric acid. Solubility of uranium in the dissolver product and the species precipitated are discussed. A stable region for Nb–Al–F solutions is defined. The corrosion of stainless steel is evaluated with respect to the degree of complexing of the fluoride by niobium. A dilute uranium dissolver product with minimum fluoride-to-niobium mole ratio, completely complexed at 0.4 M aluminum or less, is the best extraction feed from the standpoint of stability and corrosion of extraction equipment. (auth)

57520 (JINR–E6-5952) ELECTROMIGRATION SEPARATION OF TRANSURANIUM ELEMENTS IN SOLUTIONS OF ETHILENDIAMINTETRACETIC AND CYCLOHEX ANDIAMINTETRACETIC ACIDS. Buklanov, G. V.; Korotkin, Yu. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 8p. Dep. NTIS (U. S. Sales Only).

Electromigration separation of a mixture of transuranium elements in solutions of EDTA and CDTA was carried out. Clear separation of Am and Cm was achieved. Electromigration behavior of Po, Ac, Th, Pa, and Ra under the same conditions was investigated. The possibility of fast separation of microquantities of transuranium elements and milligrams of lanthanum is shown. (auth)

57521 (KURRI-TR–76, pp 15-18) RAPID CHEMICAL SEPARATION. Kusaka, Yuzuru (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on nuclei with short life; Osaka, Japan (30 Jun 1969).

In Reports of the study meeting on nuclei with short life.

A proper separation method in radiochemistry is a method to obtain elements with high purity and large yield within a short time in comparison with lifetime of the elements. The following factors determine the mode of separation: chemical and physical properties of the nuclide to be separated, half-life of the nuclide, kinds and amounts of nuclides existing together, and daughter nuclei in decay series. The mode is classified by half-life as superfast ($T_{1/2} < 1$ min), fast (1 min $< T_{1/2} < 20$ min), and conventional ($T_{1/2} > 20$ min). Steps of the fast separation are preparation of a target, irradiation, transportation of the target, separation (gas separation, recoil method, extraction, ion-exchange method, precipitation or electrochemical separation), preparation of samples to be measured, and measurement of yield. When the life-time is very short, e.g., less than 1 min, all the steps of the separation should be finished within 1 min. In this case, the separation in the gas phase or the recoil method is applied, and the on-line or loop method is employed for the transportation. Steps of the gas phase separation are phase transfer, gas sweeping, and gas collection. Hot atoms produced by nuclear reaction have large recoil energy, and emerge from the target spontaneously. Separation of Kr and Xe has been studied, and many experiences were reported. A distillation method is used to separate volatile elements or compounds. Separated gas is collected by condensation, absorption, pyrolysis, chemical fixation, or electrostatic collection. (Japan)

57522 (ORNL–4676, pp 234-71) MOLTEN-SALT PROCESSING AND PREPARATION. (Oak Ridge National Lab., Tenn.). Aug 1971.

In Molten-Salt Reactor Program semiannual progress report for period ending February 28, 1971.

FLUORIDES—purification of molten, method for continuous
FLUORINATION—equipment for, corrosion and development of frozen-wall
LITHIUM ALLOYS—Bi–Li, solvent properties for neodymium and thorium
MOLTEN SALT BREEDER REACTOR—fuel reprocessing for, flowsheet analysis for
NEODYMIUM—solubility in lithium–bismuth solutions
PROTACTINIUM—separation from MSBR fuel by fluorination and reductive extraction
—preparation from MSBR fuel by oxide precipitation
RARE EARTHS—separation from MSBR fuel by extraction using liquid metals
REACTOR FUELS—reprocessing of molten salt, flowsheet analysis for
THORIUM—solubility in lithium–bismuth solutions
URANIUM—separation from MSBR fuel by fluoride volatility process, flowsheet analysis for
—separation from MSBR fuel by oxide precipitation (M.C.G.)

57523 (ORNL–4677) RADIOACTIVE CONTAMINATION OF COPPER RECOVERED FROM ORE FRACTURED WITH NUCLEAR EXPLOSIONS. Arnold, W. D.; Crouse, D. J. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 55p. Dep. NTIS.

Results of laboratory tests simulating the processing of copper ore after fracturing with nuclear explosives indicate that only very small fractions of the radioactive fission products and neutron activation products will be dissolved on leaching with sulfuric acid. Tritium (as tritiated water) will be, by far, the dominant radionuclide in the circulating leach liquor, assuming use of a fusion device. Copper that was recovered from the leach solution by cementation was significantly contaminated with ^{106}Ru. The ^{106}Ru was rejected effectively in electrolytic purification; therefore, the final copper product should be very weakly radioactive and not hazardous to the customer. However, the radioactivity level may be high enough to make the copper unsuitable for some specific uses. The tritiated water in the leach liquor and the ^{106}Ru in the cement copper are potential problems at the plant site and should be carefully considered in the design and in the operation of the facility. However, since the radioactivity levels would be low, adequate protection for the operating personnel should be neither difficult nor costly to provide. Results of these tests showed that the use of solvent extraction as an alternative to cementation for recovering copper from the leach liquor would have important advantages. Since copper is efficiently separated from radionuclides in the extraction step, radioactivity in the processing operations beyond the extraction contactors should be negligible. The radioactivity level of the final copper product recovered from the solvent extraction strip solution by electrowinning should be almost undetectable; therefore, marketing of the copper should not present any difficulties. Because of the superior marketability of the product and the much simpler radiation control problems at the processing site, use of the solvent extraction—electrowinning flowsheet is recommended. (auth)

57524 (ORNL-TM–3343) SUMMARY OF THE CAMPAIGN DURING FEBRUARY 1969 TO PROCESS SIX IRRADIATED HFIR TARGETS IN THE TRANSURANIUM PROCESSING PLANT. King, L. J.; Collins, E. D. (Oak Ridge National Lab., Tenn.). Aug 1971. Contract W-7405-eng-26. 45p. Dep. NTIS.

Six irradiated HFIR targets were processed in the Transuranium Processing Plant (TRU) to recover the transuranium elements. This was the first campaign in which recycle americium–curium targets were processed. Prior to irradiation, each of the targets contained approximately 4.38 g of ^{244}Cm, 0.34 g of heavier curium isotopes, and 0.78 g of ^{243}Am that had been recovered in TRU from irradiated plutonium targets. The six targets had been fabricated in the remote target fabrication equipment in TRU, using americium–curium oxide powder, which had been prepared during development studies of the curium sol-gel process. Purified products contained about 0.3 g of ^{243}Am, 17 g of ^{244}Cm, 1.2 mg of ^{249}Bk, 9.2 mg of ^{252}Cf, 68 μg of ^{253}Es and 10^8 atoms of ^{257}Fm. Processing steps were: dissolution of the aluminum using caustic–nitrate solution, dissolution of the actinide oxides using concentrated hydrochloric acid, removal of radioiodine and recovery of plutonium using a batch solvent extraction process (Pubex), decontamination of the transplutonium elements using the Tramex solvent extraction process, and separation of americium and curium from the transcurium elements using a LiCl-based anion exchange process. The transcurium elements were separated and purified using laboratory-scale equipment installed in one of the processing cells. Newly-installed metal (tantalum) equipment for the LiCl-based anion exchange process performed satisfactorily. All product fractions were taken based on continuous in-line alpha monitoring of the column effluent line and on neutron and gamma scans of the tantalum column. Only 300 millicuries of ^{131}I (of 400 curies present in the targets) were released from TRU during the campaign. Most of the iodine-bearing off-gas was confined to a 3-cfm stream, and an experimental iodine removal system was installed in this small stream. The treatment system was composed of a caustic scrubber to remove acid vapors, a heater, a bed of oxidation catalyst (operated at 350°C), a cooler, and a bed of KI-impregnated charcoal. The 3-cfm off-gas stream was decontaminated from ^{131}I by a factor (DF) as high as 10^4. (auth)

57525 (RFP–1723) EVALUATION OF METHODS TO RECOVER PLUTONIUM FROM INCINERATOR ASH. Ziegler, Donald L.; Lindsay, John W.; Fraser, John K. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 16 Aug 1971. Contract AT(29-1)-1106. 10p. Dep. NTIS.

Laboratory experiments were performed to evaluate the methods of hydrochloric acid leaching, nitric acid leaching, various fusion-leaching, and fluorination-leaching used for removal of plutonium from incinerator ash and residue from leached incinerator ash. Three precipitation methods were evaluated for removing the plutonium from a hydrochloric acid solution. The results indicate that the hydrochloric leaching of ash, coupled with a lanthanum fluoride-carried precipitation, is superior to other methods tested from recovering plutonium from incinerator ash. (auth)

57526 (UCRL–73190(Rev.1)) LIQUID CHROMATOGRAPHY. I. HIGH SPEED SEPARATION OF THE RARE EARTHS. Sisson, D. H.; Mode, V. Alan (California Univ., Livermore. Lawrence

Radiation Lab.). May 1971; Revised Aug 1971. 13p. (CONF-710711-2). Dep. NTIS.

From fourth conference on liquid chromatography; Los Angeles, Calif. (8 Jul 1971).

A high-pressure liquid chromatographic technique using α-hydroxyisobutyric acid as eluant is presented that will allow rare earth separation, Lu through La, in three to four hours. (D.H.M.)

57527 (UJV-2557-Ch) PARTITION CHROMATOGRAPHY OF URANIUM AND FISSION PRODUCTS ON POROUS STYRENE-DIVINYLBENZENE COPOLYMER SWOLLEN IN THE SOLUTION OF TRIBUTYLPHOSPHATE. III. PROPERTIES OF COPOLYMER AS CARRIERS OF STATIONARY PHASE AND PREPARATION OF SWOLLEN GELS. Literature Survey. Beranova, H.; Tejnecky, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Jun 1971. 38p. Dep. NTIS (U. S. Sales Only).

The literature concerning partition chromatography is surveyed. Properties of styrene–divinylbenzene copolymers as carriers of stationary phase are evaluated. The preparation of swollen gels and the concentration of tributyl phosphate in swollen gels were studied in relation to the tributyl phosphate concentration in the swelling agent, diluent type, and divinylbenzene content in standard (S) and macroporous (P) copolymers. Porous copolymers were convenient as carriers of the organic phase in accordance with the original assumption. The effects of surfaces or pore volume of porous copolymers were determined for some compounds that did not swell the copolymers. The sorption of nitric acid and hydrochloric acid was examined for the concentration range in the liquid phase 1 to 8M. The heats of swelling were measured for chosen copolymer–diluent system and the results were applied for the swelling process evaluation. (112 references). (auth)

57528 (UR–3999-11) CALCULATION OF SOME ISOTOPE SEPARATION FACTORS FOR CHEMICAL EXCHANGE, DISTILLATION, EXCHANGE DISTILLATION, AND ABSORPTION USING $UF_{6(g)}$. Bigeleisen, Jacob (Rochester Univ., N. Y. Dept. of Chemistry). [1971]. Contract AT(30-1)-3999; Subcontract 3234. 18p. Dep. NTIS.

The reduced partition function of $({}^{238}UF_6/{}^{235}UF_6)_g$ was calculated from the vibrational potential function of Claassen in good agreement with a previous calculation by Mayer and Bigeleisen. Implications of this calculation with respect to chemical exchange reactions of $UF_{6(g)}$ with complexes of UF_6 are discussed. The quantum mechanical theorem of corresponding states and the vibrational spectra of $UF_{6(g)}$, $UF_{6(l)}$, and UF_6 dissolved in C_7F_{16} were used to calculate $\ln(f_c/f_g)$ in the liquid and solution. These lead to $\ln\alpha$ values for distillation and absorption of -4×10^{-5} and -6×10^{-5}, respectively. ${}^{238}UF_6$ was calculated to be more volatile than ${}^{235}UF_6$ in agreement with experiment. The feasibility of separation of uranium isotopes by exchange chromatography is discussed. (auth)

57529 LIQUID WASTES OF RADIOLOGICAL INSTITUTES AND ISOTOPE DIVISIONS. Mende, H. Sanit. Heizungstechnik: 35: No. 10, 641-7(1970). (In German).

The treatment of radioactive waste solutions of radiological institutes are described taking the "Strahlenschutzverordnung" of the Federal Republic of Germany as the basis of the considerations. Special emphasis is given to clinical laboratories and the equipment for storage and decontamination is illustrated. (INIS)

57530 ISOLATION OF BERKELIUM ON A ZIRCONIUM PHOSPHATE–SILICATE SORBENT. Myasoedov, B. F.; Barsukova, K. V.; Rodionova, G. N. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Radiochem. Radioanal. Lett.; 7: No. 5-6, 269-74(10 Sep 1971).

A simple and effective method for isolation of berkelium on a zirconium phosphate–silicate sorbent in a mixture with lead dioxide was proposed, which ensures the quantitative and selective isolation of berkelium from solutions of complex composition containing other transplutonium and fission elements. The method consists in the successive passing of a 1M nitrate solution containing berkelium through two columns. On the first column filled with a pure zirconium phosphate–silicate sorbent Pu^{4+}, Cs, Nb, Zr, and partly Ru are separated. Then the solution is passed through the second column filled with a mixture of the same sorbent and PbO_2 where tetravalent berkelium is separated from macroamounts of Al, corrosion products, as well as from transplutonium and rare earth elements. The separation of Bk from Ce occurs on the lower bed of the second column, which is a mixture of anionite Dowex – 1 × 4 and PbO_2. (auth)

57531 TREATMENT OF SUSPENSIONS OR SOLUTIONS OF SOLID RADIOACTIVE MATERIAL IN LIQUID. (to Siemens Aktiengesellschaft). British Patent 1,242,665. 11 Aug 1971. Priority date 29 Jun 1968, Germany.

This method for the treatment of a suspension or solution of a solid radioactive material in a liquid involves concentrating the suspension or solution by evaporation, adding a film-forming agent to increase viscosity, and adding a binding agent. The suspension or solution is then dried in order to obtain a mass of solid material that is placed into a cask lined with a material that absorbs radiation. The film-forming agent is polyacrylamide and the binding agent is bone glue. The proposed method is cheaper and freer from dust than methods involving the imbedding of the radioactive waste material in bitumen or cement mixtures. (J.G.B.)

57532 CONTRIBUTION TO STUDIES ON GASEOUS RuO_4 REMOVAL BY MEANS OF FERRIC OXIDE-SILICA FILTERS. Donato, A.; Bocola, W. (CNEN, Rome). Energ. Nucl. (Milan); 18: No. 6, 353-9(Jun 1971).

The behavior of a ferric oxide–silica filter for ruthenium tetroxide removal from gases was studied. Removal occurs through RuO_4 decomposition mainly in the first layer of filtering material. At a temperature higher than 200°C, gas flowrates lower than 6 l/min and RuO_4 amounts less than 40 mg/min, the filter efficiency has been found higher than 99.9%. Filter efficiency increases with temperature increases and gas flowrate and RuO_4 amount decreases. (auth)

57533 EXTRACTION OF HAFNIUM WITH CYCLOHEXANONE SOLUTION OF THIOCYANIC ACID. Motov, D. L.; Skabichevskaya, G. I. J. Appl. Chem. USSR (Engl. Transl.); 44: No. 2, 247-51(Feb 1971).

Translated from Zh. Prikl. Khim.; 44: No. 2, 249-54(Feb 1971).

A study was made of the extraction of hafnium from sulfate solution obtained during treatment of native ore containing zirconium. The extraction of hafnium from sulfate solutions into cyclohexanone solutions of thiocyanic acid showed that two- or three-stage extraction at 1 : 1 volume ratio of the original sulfate solution containing zirconium to the cyclohexanone solution of thiocyanic acid gives a zirconium raffinate in which the admixture of hafnium to zirconium is about 0.02%, and also an extract containing 10 to 15% HfO_2 in Σ-zirconium and hafnium oxides. Conditions were found for stripping zirconium from the extract, giving a hafnium extract containing about 90% HfO_2 in $\Sigma\ HfO_2 + ZrO_2$. (auth)

57534 IRRADIATED NUCLEAR FUEL RECOVERY PROCESS. Weech, Marx Elson (to General Electric Co.). British Patent 1,240,766. 28 Jul 1971. Priority date 18 Jun 1968, United States.

A method for the recovery of irradiated nuclear fuel is presented. The irradiated fuel, which consists mainly of uranium or a uranium compound, is dissolved in an aqueous HNO_3 solution. This fuel solution is contacted with an organic solvent composed of TBP and a water-immiscible hydrocarbon solvent to extract U, Pu, and Np. The organic solution is passed countercurrent to an aqueous reflux stream containing sufficient U to maintain the organic solution at at least 90% of U saturation, while Pu, Np, and fission products are being scrubbed from the solution. The aqueous reflux stream is stripped of its U using TBP and a water-immiscible hydrocarbon solvent. An aqueous stream is then used to strip the U from the organic solution. A one-cycle multi-stage reflux column may be used for the process. (J.G.B.)

57535 BEHAVIOR OF NEPTUNIUM IN AQUEOUS SOLUTION. II. STABILITY OF PENTAVALENT NEPTUNIUM ION. Chang, Chau-ting; Liaw, Chiu-fong (National Tsing Hua Univ., Hsinchu, Taiwan). J. Inorg. Nucl. Chem.; 33: No. 8, 2717-20(Aug 1971).

The extraction behavior of Np(V) with TTA under the masking effect of EDTA was investigated. The dependence of the distribution coefficient, D, on pH at (EDTA) = 10^{-4} M and fixed (TTA) is illustrated graphically. D was found to increase with pH, attaining a maximum at pH of about 7, and then to decrease. The variation of D with respect to (HT) at pH 5.30 and (EDTA) = 10^{-4} M is also shown graphically. The slope was found to vary between +1 and +2. The slopes of the curves showing the dependence of apparent distribution coefficient on EDTA concentration at pH = 5.30 and fixed TTA varied between 0 and –1. Equilibrium constants for various reactions are tabulated. (UK)

57536 UNDERGROUND LEACHING OF URANIUM AT THE PITCH MINE. Marrs, Len F. Mining Congr. J.; 56: No. 11, 35-6; 41-3(Nov 1970).

High-grade U ore is being recovered by underground leaching. Research on raising the recovery rate for the ore with different solutions is in progress and it was found that increasing pH and bicarbonate levels and temperature increase production. The feed from the mill is processed through a clarifier and then treated in an ion-exchange column. An elution column strips out the U, which is precipitated as uranium hydroxide and dried to produce a product with 83% U_3O_8. (Metals Abstr.)

XUM

57537 DETERMINATION OF THE DISSOCIATION CONSTANTS OF THE DOUBLE COMPLEXES OF THE TYPE $MeY_2H_n^{(3-n)-}$ FORMED BETWEEN TRIVALENT LANTHANIDES AND HYDROXYETHYLENEDIAMINETETRAACETIC ACID. Merciny, E.; zur Nedden, P.; Duyckaerts, G. (Univ. Liege, Sart Tilman, Belg.). Anal. Lett.; 4: No. 1, 29-40(Jan 1971). (In French).

The complexes $MeY_2H_n^{(3-n)-}$ formed between trivalent lanthanides and HEDTA [indexed to N-(carboxymethyl)-N′-(2-hydroxyethyl)-N,N′-ethylenediglycine] are studied with the idea of determining their stability constants and their degree of protonation. The method is based on the titration curve of the chelating agent in the presence of an equimolar quantity of the complex MeY. (auth)

57538 HYDROGEN/DEUTERIUM SEPARATION FACTORS ON CATHODE AND DIFFUSION SIDES OF 25% Ag–Pd FOILS. Smith, Frank R. (Memorial Univ. of Newfoundland, St. John's); Hammerli, Martin Z. Phys. Chem. (Frankfurt); 74: No. 1-2, 75-7 (1971).

Separation factors for the separation of deuterium from hydrogen were measured for the gas evolved on the cathode side of Ag–Pd foils and for the gas produced after diffusion through the foils and subsequent combination. Mass spectrometric analysis of the gases made it possible to compare simultaneously the separation factors on both sides of the alloy foil. Unexpected time dependences were revealed. (J.G.B.)

57539 PROCESS AND APPARATUS FOR THE CONTINUOUS DISSOLVING TREATMENT OF SHEATHED NUCLEAR FUELS WITH A LIQUID. (to Saint-Gobain Techniques Nouvelles). British Patent 1,240,517. 28 Jul 1971. Priority date 24 Sep 1968, France.

A process for the continuous treatment of sheathed nuclear fuels with a liquid that will dissolve all parts of the fuel is described. The fuel elements are fed at a steady rate to several baskets, one after another, and immersed in a dissolving bath. The part of the element remaining in the first basket after the other part has been dissolved, but before all the baskets have been filled with fuel elements, is transferred to a rinsing bath, then removed. The liquid is fed to the rinsing bath at a steady rate, transferred to the dissolving bath, then drawn out at a constant rate. Preferably the level of liquid in the rinsing bath is maintained above the level of liquid in the dissolving bath. The result is that the rate of feed of the fuel elements and the rate of flow of the liquid into and out of the dissolving bath remain constant, the liquid and the elements being circulated in opposite directions. The only noncontinuous part of the process is the removal of the fuel or the sheaths, according to whether the liquid in the baths attacks the sheath or the fuel in the irradiated elements. The term "element" is intended to include both the uncut rod and sheath and also sections of cartridge filled with nuclear fuel. The invention extends to the design of various components of the continuous treatment apparatus. (J.G.B.)

57540 TREATMENT AND FINAL DISPOSAL OF RADIOACTIVE WASTE. Krause, H. (Gesellschaft fuer Kernforschung mbH, Karlsruhe, Ger.). Atomwirt., Atomtech.; 16: No. 8-9, 461-7(Aug-Sep 1971). (In German).

Experience obtained from more than one decade of collecting, treating, and final storing of radioactive waste in the FRG is summarized. The data reveal the possibility for handling all radioactive waste produced by nuclear energy installations in such a way that the remaining effluent radioactivity represents no danger to the environment. The Asse salt mine alone, with the addition of a few technical installations, will be able to store all radioactive waste produced in the FRG up to the year 2000. (tr-auth)

57541 THOREX TWO-STAGE PROCESS FOR REPROCESSING THORIUM REACTOR FUEL WITH HIGH BURNUP. Kuechler, L.; Schaefer, L.; Wojtech, B. (Farbwerke Hoechst AG, Frankfurt am Main). Kerntech. Atomprax.; 13: No. 7-8, 319-22(Jul-Aug 1971). (In German and English).

For the recovery of thorium and uranium from thorium reactor fuel the Thorex two-stage process was worked out that yields high decontamination factors and avoids precipitation. Hot-cell investigations showed that uranium can be decontaminated by a factor of 10^7 or more if a third uranium cycle, which was also worked out, is added to the Thorex two-stage process. (auth)

57542 REPROCESSING OF OXIDIC THORIUM-CONTAINING NUCLEAR FUEL PARTICLES WITH CHLORINE GAS. Knotik, K.; Bildstein, H. (Reaktorzentrum, Seibersdorf, Austria). Kerntech. Atomprax.; 13: No. 7-8, 323-9(Jul-Aug 1971). (In German and English).

Experimental studies are described on chloride extraction from coated uranium–thorium oxide particles. A description of the chlorinating apparatus and of the working method is followed by a discussion of the results (yield and enrichment factor of uranium). The reaction conditions were determined on the basis of results obtained in a preliminary thermogravimetric study of the chlorination of uranium carbide and thorium carbide particles. (auth)

57543 SEPARATION FACTORS IN A EUROPIUM CHLORIDE–SAMARIUM CHLORIDE–NEODYMIUM CHLORIDE–DI(2-ETHYLHEXYL)PHOSPHORIC ACID SYSTEM. Matsumoto, Akira; Takatsuji, Kazuhiko; Hirashima, Yoshiyuki; Shiokawa, Jiro (Osaka Univ.). Kogyo Kagaku Zasshi; 74: No. 7, 1328-31(Jul 1971). (In Japanese).

In a system of their aqueous chloride solutions and a solution of 1.0 mole/l of D2EHPA in n-heptane, the effects of three factors were studied on the distribution coefficients of the three elements and on the separation factors of europium with respect to samarium ($\beta_{Eu,Sm}$) and neodymium ($\beta_{Eu,Nd}$). The three factors were: HCl concentration (0.25, 0.50, 0.75 mole/l), total rare earth concentration (0.25, 0.50, 0.75 mole/l) and mole ratio (Eu : Sm : Nd = 1 : 5 : 100, 1 : 5 : 10, 1 : 2.5 : 10, 1 : 5 : 1, 1 : 1.25 : 1). As the distribution coefficient of Eu approximated that of Sm compared to the single component system, Eu and Sm behaved similarly in the extraction. The distribution coefficient of Nd decreased with an increase in the concentration of the two elements. The extraction of Nd was suppressed subsequently by the coexistence of the two elements. On the effects of $\beta_{Eu,Sm}$ and $\beta_{Eu,Nd}$, all the three factors were highly significant and the interaction of the factors was found in the case of $\beta_{Eu,Nd}$. These separation factors and the distribution coefficients of the three elements in the mixed system decreased with an increase in the concentration of HCl, of total rare earths, and of Eu in the mixed solution, respectively. (auth) (Japan)

57544 ACIDIC ORGANODIPHOSPHORUS EXTRACTANTS. PART V. EXTRACTION DEPENDENCY OF TRIVALENT EUROPIUM ON THE DIELECTRIC CONSTANT OF THE ORGANIC PHASE. Jamil, M.; zur Nedden, P.; Duyckaerts, G. (Univ., Liege). Anal. Lett.; 4: No. 2, 87-93(Feb 1971).

The extraction of Eu(III) was carried out from a 1 M (H,Na)ClO_4 solution into different organic solvents at constant total concentration (6.67×10^{-3} M) of the extractant, di-n-butyl ethane-(1,2)-diphosphonate (H_2B_2EDP). The distribution coefficient of Eu(III) is influenced quite appreciably by the nature of the organic solvent. The distribution coefficient can vary by a factor of 10^6 for two solvents such as chloroform and isooctane. The experimental results are compared with those previously reported that were obtained by using di-n-butyl phosphate (HDBP) for the extraction of Eu(III) into different organic solvents. If it is assumed that H_2B_2EDP remains a monomer for a total concentration of 6.67×10^{-3} M in the solvents used, then it may be concluded that the extraction of Eu(III) by the associated HDBP or the monomer H_2B_2EDP is influenced in the same manner in the solvents used. (auth)

57545 METHOD AND APPARATUS FOR THE PURIFICATION OF HEAVY WATER. Dirian, Gregoire; Roth, Etienne (to Commissariat a l'Energie Atomique). British Patent 1,247,590. 22 Sep 1971. Priority date 21 Jun 1968, France.

The proportion of hydrogen and tritium contained in a continuous stream of heavy water withdrawn from a nuclear reactor is lowered by an isotopic exchange reaction with deuterium gas. The heavy water is returned to the reactor and the deuterium gas thus enriched in hydrogen and tritium is subjected to fractionation by chromatography. The apparatus is shown in diagrams. (M.C.G.)

57546 EXTRACTION OF PROTACTINIUM AND ITS ANALOGS FROM SOLUTIONS OF OXALIC AND TARTARIC ACIDS WITH TRIBUTYLAMINE. Pal'shin, E. S.; Ivanova, L. A.; Davydov, A. V. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 43-7(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 48-52(Jan-Feb 1971).

The extraction of protactinium and its analogs from solutions of oxalic and tartaric acids by tributylamine in chloroform was studied. Protactinium and its analogs, Nb, Ta, Zr, are quantitatively extracted by a 0.22 M solution of TBA in chloroform from 0.1 to 0.5 M solutions of $H_2C_2O_4$. The extraction of the elements from tartaric acid solutions is less effective. The distribution of oxalic, tartaric, and phosphoric acids between the aqueous solution and TBA in chloroform was investigated. Tartaric and phosphoric acids are practically not extracted by the amine. This indicates the possibility of the use of extraction from solutions of oxalic acid with tributylamine for separation of the elements from phosphate and tartrate anions. (auth)

57547 INVESTIGATION OF PROCESSES OF OXIDATION AND DISSOLUTION OF URANIUM COMPOUNDS IN NONAQUEOUS MEDIA. I. DISSOLUTION OF URANIUM OXIDES IN SOLUTIONS OF EXTRACTION REAGENTS SATURATED WITH MINERAL

ACIDS. Filippov, A. P.; Strelkov, L. A. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 48-52(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 52-7(Jan-Feb 1971).

The possibility of selective dissolution of sparingly soluble compounds of uranium by various classes of extraction reagents in conjunction with oxidation processes, shown in this work, demonstrates a new application of extraction reagents for the direct extraction of uranium from various materials without their preliminary dissolution in acid. (auth)

57548 INVESTIGATION OF PROCESSES OF OXIDATION AND DISSOLUTION OF URANIUM COMPOUNDS IN NONAQUEOUS MEDIA. II. INFLUENCE OF THE FORM OF EXISTENCE OF NITRIC ACID IN THE TBP–HNO_3 SYSTEM ON THE PROCESS OF OXIDATION AND DISSOLUTION OF UO_2. Strelkov, L. A.; Filippov, A. P. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 53-7(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 58-62(Jan-Feb 1971).

The effective process of oxidation and dissolution of UO_2 proceeds in a TBP solution saturated with nitric acid at an equilibrium concentration of HNO_3 in the aqueous phase greater than 4M (the mole ratio $[HNO_3]_0/TBP > 0.6$). The oxidizer of U(IV) in TBP solutions is molecular nitric acid, contained in the complex TBP · $2HNO_3$ with lower stability constant. The oxides of nitrogen liberated in the oxidation of uranium are capable of repeatedly participating in the processes of oxidation and dissolution, as a result of which the degree of utilization of nitric acid in the process increases. (auth)

57549 INVESTIGATION OF COMPLEX FORMATION WITH DIETHYLENETRIAMINEPENTAACETIC ACID. I. PRASEODYMIUM(III). Piskunov, E. M.; Rykov, A. G. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 78-83(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 84-9(Jan-Feb 1971).

In separation studies it was established by pH-potentiometric and spectrophotometric methods that at an equimolar ratio of the concentrations of DTPA and praseodymium(III) in the region of pH from 1.0 to 3.6, only one complex is formed with the composition PrA^{2-} (20°, $\mu = 0.5$). Good agreement of the stability constants of the complex PrA^{2-}, determined by two independent methods, was obtained. (auth)

57550 SEPARATION OF THE ACTINIDES AND LANTHANIDES ON ZIRCONIUM PHOSPHATE. I. SEPARATION OF NEPTUNIUM(V), PLUTONIUM(IV), AND PROMETHIUM(III). Shafiev, A. I.; Efremov, Yu. V.; Nikolaev, V. M.; Yakovlev, G. N. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 120-2 (Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 126-9(Jan-Feb 1971).

The possibility of the chromatographic separation of Np(V)–Pu(IV)–Pm(III) on zirconium phosphate was demonstrated. In this case Np(V) is not retained by the ion exchanger, while the trivalent elements are eluted with 1 N HNO_3. Plutonium(IV) is eluted by rapid-action reducing agents in 0.5 to 1N HNO_3, such as 0.1N solutions of Mohr's salt, iron sulfamate, or hydroquinone. (auth)

57551 SEPARATION OF THE ACTINIDES AND LANTHANIDES ON ZIRCONIUM PHOSPHATE. II. SEPARATION OF AMERICIUM(V), (VI), AND CURIUM(III). Shafiev, A. I.; Efremov, Yu. V.; Nikolaev, V. M.; Yakovlev, G. N. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 123-5(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 129-31(Jan-Feb 1971).

Am(V) is not sorbed by zirconium phosphate and is entirely eluted by the "blank" solution. Am(VI) is retained more firmly by zirconium phosphate and is eluted with a solution of 0.05 to 0.15N HNO_3. Cm(III) behaved in exactly the same way as Pm(III), i.e., it is eluted together with Pm(III) by a solution of 1 N HNO_3. The results on the separation of a mixture of americium and curium with promethium are presented. The experiments show that zirconium phosphate is stable in oxidizing media and has no reducing effect on Am(V) and Am(VI), and it can be used to separate americium from curium and the trivalent lanthanides. (auth)

57552 SEPARATION OF RUTHENIUM, RHODIUM, AND PALLADIUM BY COPRECIPITATION WITH FERRIC HYDROXIDE. Novikov, A. I.; Rustamov, S. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 130-2(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 134-7(Jan-Feb 1971).

The coprecipitation of small quantities of ruthenium, rhodium, and palladium with ferric hydroxide in 1M solutions of ammonium nitrate and chloride was studied as a function of the pH of the medium. There was no coprecipitation of palladium under the indicated conditions; ruthenium was entirely sorbed in the interval of pH = 7 to 8 and not coprecipitated at a KOH or NaOH concentration more than 3M; rhodium was entirely coprecipitated in the interval of pH from 7 up to 3M KOH or NaOH. The elements are separated by successive coprecipitation of ruthenium and rhodium with ferric hydroxide in solution of ammonium salts at pH = 7 to 8, and in this case palladium is not sorbed by the precipitate of the carrier. Rhodium is separated from ruthenium by secondary coprecipitation with ferric hydroxide in a 3M solution of alkali in the presence of ammonia. Rhodium is separated from the carrier by reprecipitation of the ferric hydroxide at pH = 3 to 3.7 in a solution of 1M ammonium chloride and 0.2M hydrogen peroxide. (auth)

57553 SEPARATION OF THE ACTINIDE ELEMENTS AND THEIR VALENCE FORMS BY PARTITION PAPER CHROMATOGRAPHY AND THIN-LAYER CHROMATOGRAPHY. Korotkin, Yu. S. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 133-6(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 137-40(Jan-Feb 1971).

The possibility of the separation of a mixture of certain actinide elements and their valence forms in HNO_3 and $HClO_4$ by the method of partition chromatography on paper impregnated with tetrabutylhypophosphoric acid as demonstrated. Milligram quantities of U, Np, Pu, as well as Am were separated by thin-layer chromatography on Teflon-40. (auth)

57554 SEPARATION OF PLATINUM FROM THE DAUGHTER ISOTOPE OF GOLD. ISOLATION OF PLATINUM IN RADIOCHEMICALLY PURE FORM. Rakovskii, E. E.; Rabinovich, B. S.; Starozhitskaya, M. I. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 144-6(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 146-8(Jan-Feb 1971).

The possibility of producing platinum in radiochemically pure form, using extraction of the tetrachloroaurate ion with triphenylguanidinium chloride for the separation of gold, was investigated. (M.C.G.)

57555 ION EXCHANGE FIBERS AND FABRICS. II. ANION EXCHANGE FIBERS AND FABRICS STABLE IN AGGRESSIVE MEDIA. Laskorin, B. N.; Smirnova, N. M.; Yuzhina, A. D.; Semenova, E. I.; Savel'eva, T. I. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 161-4(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 160-2(Jan-Feb 1971).

The possibility of producing anion exchangers of the ÉDÉ-10P type on the basis of fluoropolymers, in the form of a powder or fabric, and polyethylenepolyamines was investigated. The optimum conditions of synthesis were determined. The synthesized anion exchangers AF-1, AF-2, and AF-3 contain 11.0, 2.6, and 6.2% nitrogen and have a total exchange capacity of 3.8, 1.05, and 4.2 meq/g, respectively. The anion exchangers sorb uranium from artificial sulfuric acid solutions (C_{eq} = 1 g/liter) in amounts of 100 to 110, 27.0, and 61.0 mg/liter for the exchangers AF-1, AF-2, and AF-3, respectively. When the uranium concentration in solution is increased to 19 g/liter, the capacity of the anion exchangers increases, reaching 170 mg/g for AF-3 fabric. The anion exchange fabrics obtained can be used to sorb the anions of acids and various metals in anionic form from solutions. (auth)

57556 DEACTIVATION OF RADIOACTIVE SEWAGE BY THE METHOD OF TWO-STEP COAGULATION OF FERRIC HYDROXIDE. Zolotavin, V. L.; Konstantinovich, A. A.; Sanatina, V. N.; Pushkarev, V. V.; Petrov, V. S. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 167-9(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 164-6(Jan-Feb 1971).

Use of a two-step process of coagulation, in comparison with one-step coagulation with the same consumption of iron sulfate, increases the degree of deactivation of radioactive sewage with respect to α activity by 12 to 20-fold, and the β activity by 2 to 5-fold. (auth)

57557 ON THE ARTICLES, STUDY OF THE RATE OF EXTRACTION IN SYSTEMS WITH TRIBUTYL PHOSPHATE, BY M. F. PUSHLENKOV AND N. N. SHCHEPETIL'NIKOV. Fomin, V. V. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 170-1(Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 167-8(Jan-Feb 1971).

57558 RAPID SEPARATION OF FISSION-PRODUCT RARE EARTHS AND YTTRIUM BY ELECTROMIGRATION. Ohyoshi, Emiko (Kumamoto Univ., Japan); Ohyoshi, Akira; Tamai, Tadaharu; Shinagawa, Mutsuaki. J. Nucl. Sci. Technol. (Tokyo); 8: No. 8, 444-9(Aug 1971).

The separation of fission-product La, Ce, Pr, Nd, and Y was performed in 4 min by electromigration. As complexing agent, nitrilotriacetic acid was used at two concentrations of the NTA ion selected so as to optimize mutual separation of the elements. Rapid location of the zone on the paper strip reached after migration was obtained by color reaction of the carrier added to the irradiated sample. The purity of the elements thus separated was checked by γ spectrometry. At the higher concentration of NTA ([NTA] = $1.0 \times 10^{-2}_{M}$, pH = 4.1) under which all of rare earths and Y migrate toward the anode, the elements were well separated from each other, although appreciable amounts of other F.P. were also found in each fraction. On the other hand, at the lower NTA concentration ([NTA] = $4.0 \times 10^{-3}_{M}$, pH = 2.0) where the F.P. all migrate toward the cathode, each zone contained the isotopes of the respective element almost exclusively, except for a few small photopeaks attributable to other elements. In each fraction, the 92.5-min ^{142}La and 14-min ^{143}La, the 14-min ^{146}Ce (24-min ^{146}Pr), the 24-min ^{146}Pr and 12-min ^{147}Pr, the 1.8-hr ^{149}Nd, the 20.3-min ^{94}Y and 10.9-min ^{95}Y were identified from the energies of photopeaks and their decay rates. (auth)

57559 POSSIBILITIES OF RAPID SEPARATION OF RADIOIODIDE, RADIOIODATE, AND RADIOPERIODATE. Palagyi, S.; Zaduban, M. (Prirodovedecka Fakulta UPJS, Kosice, Czech.). Radioisotopy; 11: No. 5, 835-49(1970). (In Czech).

Possibilities of the rapid separation of radioiodide, radioiodate, and radioperiodate based on paper, ion-exchange, and thin-layer chromatography and electrophoresis are described. Attention was paid mainly to the separation of individual chemical forms of a carrier-free radioiodine and radioiodine with a carrier on the untreated and chemically treated paper and on the thin-layer. The preparation of the carrier-free $^{131}IO_3^-$ and $^{131}IO_4^-$ by the oxidation of $^{131}I^-$ is also described. Possibilities of the application of the separation methods presented even to other radioisotopes of iodine, such as ^{132}I, ^{133}I, ^{134}I, and ^{135}I, are discussed. (auth)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 57459, 57540, 57574, 57595, and 57596.

57560 (INP–732) PULSED NEUTRON METHOD FOR URANIUM WELL LOGGING. Czubek, Jan A. (Institute of Nuclear Physics, Krakow (Poland)). Apr 1971. 53p. (CONF-710402–3). Dep. NTIS (U. S. Sales Only).

From Meeting on neutron sources and applications; Augusta, Ga. (18 Apr 1971).

The physical principles of a new method of uranium detection based on use of a pulsed source of neutrons are presented. The method is based on measurement of the neutron time distributions in rock media following a burst of fast neutrons. A time and energy, space independent theory is developed for the four principal time distributions occurring after production of fission neutrons by each of the two possible reactions: prompt thermal fission of ^{235}U with epithermal neutron time distribution or thermal neutron time distribution; and delayed fission of uranium with neutron time distribution due to delayed fission in ^{235}U or neutron time distribution due to delayed fast fission in ^{238}U. Theoretical analysis of these phenomena leads to the conclusion that the detection of uranium in rocks is possible using either the epithermal neutron time distribution from the prompt fission of ^{235}U by thermal neutrons or the delayed neutron distribution from fast neutron fission of ^{238}U or thermal neutron fission of ^{235}U. Experiments performed in laboratory models of uranium show the feasibility of detection of fission neutrons and the validity of the theory presented. For normal borehole logging measurements, a pulsed neutron source with an average output of about 10^9 n/sec is needed. (auth)

57561 (TID–25786) RELATIONS AMONG RADIONUCLIDE CONTENT AND PHYSICAL, CHEMICAL, AND MINERAL CHARACTERISTICS OF COLUMBIA RIVER SEDIMENTS. Glenn, J. L. (Geological Survey, Portland, Oreg. Water Resources Div.). 1971. 125p. Dep. NTIS.

Contains section on Sand Mineralogy by R. O. Van Atta.

The radionuclides discussed were produced by neutron activation of elements in Columbia River water that was used to cool the once-through nuclear reactors in the Hanford area near Pasco, Wash., prior to their final shutdown early in 1971. After return of the low-level radioactive cooling waters to the Columbia River, some radionuclides were attached to sediment particles and some particles incorporated in the streambed. Data are presented on radionuclides in size separates of streambed sediments and relations among radionuclide content, particle size, cation exchange capacity, carbon and nitrogen content, and mineralogy are described. Differences in radionuclide concentrations with particle size and with sample location are evaluated in the framework of simple models for the origin of radionuclides in streambed sediments. Chromium-51, zinc-65, scandium-46, manganese-54, and cobalt-60, in decreasing order of concentration, are the gamma-emitting radionuclides identified in Columbia River size separates. Clay separates contain an average of 36 percent of the sum of the zinc-65 concentrations in all separates; fine and medium sand separates combined contain less than 2 percent of the sum of the zinc-65 concentrations in all separates. Weighting radionuclide concentrations with results from particle-size analyses shows that the relatively more abundant fine and medium sands contain nearly 45 percent of the total amount of zinc-65; the relatively less abundant clay separate contains only 16 percent. (L.C.L.)

57562 (USGS–474–110) LOG OF HYDROLOGIC TEST WELL 1, TATUM DOME AREA, LAMAR COUNTY, MISSISSIPPI. Dribble-6. Armstrong, Clarence A.; Harris, Hobart B.; Taylor, Richard E.; Chafin, Robert V.; Shows, Thad N. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 24p. Dep. NTIS.

Hydrologic Test Well 1 is located about 0.5 mi northeast of Tatum salt dome, Miss., the site of the Dribble Project. The well was drilled to a depth of 2,616 ft. Gamma ray-neutron, electric, micro, and sonic logs and drill core data were obtained to determine the depth, thickness, general characteristics, and stratigraphic sequence of geologic formations and aquifiers. Tabulated data is presented on aquifier zones, lithographic log of the test well, description of rotary cores, and chemical contents of test well water. (L.C.L.)

57563 (USGS–474–111) LOG OF HYDROLOGIC TEST WELL 2, TATUM DOME AREA, LAMAR COUNTY, MISSISSIPPI. Dribble-7. Armstrong, Clarence A.; Harris, Hobart B.; Taylor, Richard E.; Chafin, Robert V.; Shows, Thad N. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 23p. Dep. NTIS.

Hydrologic Test Well 2 is located about 0.6 mi southwest of the Tatum salt dome in Mississippi, site of the Dribble Project. The well was drilled to a depth of 2,622 ft. Gamma ray-neutron, electric, micro, and sonic logs and core data were obtained to determine the depth, altitude, thickness, and areal extent of the water-bearing strata and their stratigraphic sequence; the hydrologic characteristics, such as storage and transmissibility coefficients, of the aquifers and their relationship to the geologic conditions; the hydrostatic head and the head fluctuations that occur in the observation wells completed in the hydrologic test well; the chemical and radiochemical character of the water in the aquifers; the ion-exchange capacity of the different strata as determined from selected cores; and the effects of large detonations on aquifers. Tabulated data are presented on aquifer zones, lithographic log of the test well, description of rotary cores, and chemical contents of test well water. (L.C.L.)

57564 POLLUTION OF THE ATMOSPHERE IN URANIUM MINES. Billard, F. (CEA, Fontenay-aux-Roses, France); Madelaine, G. J.; Chapuis, A.; Fontan, J.; Lopez, A. Radioprotection; 6: No. 1, 45-61(1971). (In French).

Free ions are defined and the techniques used to determine the concentration and dimension of particles suspended in the atmosphere of French uranium mines are reviewed. Measurement by counting condensation nuclei shows that the mean concentration of particles present in the air of the mine is about 5×10^4 particles/cm^3, their average diameter being around 0.1 to 0.2 μm. The charged particle mobility spectrum shows that 60 percent of the RaA, B, and C is fixed on particles smaller than about 0.1 μm and that less than 1% is fixed on free ions. The results are discussed. (auth) (France)

57565 IVORY COAST MICROTEKTITES: FISSION TRACK AGE AND GEOMAGNETIC REVERSALS. Durrani, S. A.; Khan, H. A. (Univ. of Birmingham, Eng.). Nature (London); 232: No. 5309, 320-2(30 Jul 1971).

In the studies described the minimum track inclination with the surface that leads to successful etching (known as the critical angle) was determined using a novel comparison method. A ^{252}Cf spontaneous fission source was used to bombard first an indochinite and then a microtektite for equal lengths of time under identical 2π geometry. The two materials were then etched with HF under identical conditions. The critical angle for the microtektite was found to be 24°13′, in good agreement with that for the indochinite (25°21′) determined in a similar manner by comparison with a glass slide of known critical angle. The growth of observed etch pit densities with duration of etching for an irradiated microtektite, an indochinite, and a soda lime reference glass is illustrated. The mean value of the U content of the microtektites was found to be 0.43 ppM. It was found that the deduced ages of the microtektites appeared to coincide with the dates of the last two geomagnetic reversals, indicating a possible causal relationship. (UK)

57566 RADIOMETRIC SURVEY AT THE SOUTHERN FOOT OF Mt. OBORA, MIE PREFECTURE. Matsui, Hiroshi (Geological survey of Japan, Kawasaki); Mimura, Koji. Chishitsu Chosaho Geppo; 20: 579-87(Sep 1969). (In Japanese).

This survey was carried out in Nov. 1968 to survey the radiation intensity of the Miocene sediments at the southern foot of Mt. Obora, Japan. The Miocene group, lying unconformably on the Ryoke metamorphic complex (banded gneiss, gneissose granodiorite), is divided into the Nobori, Oigano, and Mitaki formations in ascending order. The Nobori formation is the basal conglomerate of this Miocene group and the radioactive anomalies were detected at its base in the adjacent area in 1967. No anomaly is recognized at the base of the Nobori formation and in the other two formations in this field. (auth)

57567 GAMMA SPECTROMETRIC MEASUREMENT OF SOIL RADIOACTIVITY. Mishra, U. C.; Sadasivan, S. (Bhabha Atomic Research Centre, Bombay). Int. J. Appl. Radiat. Isotop.; 22: 256-7(Apr 1971).

A gamma spectrometric method of estimating concentrations of terrestrial and long-lived bomb-produced gamma emitting isotopes in countryside soil samples is described. The method was used for measuring soil samples collected during 1964 to 1970 from different places in India from undisturbed plain and open areas. The dried samples were powdered and sieved through 30 to 40 mesh size and stored in leak proof containers for at least one

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month to allow for equilibration of radon and thoron with their daughters. The prominent gamma energies of the isotopes analysed (^{144}Ce + ^{144}Pr, ^{125}Sb, ^{106}Ru + ^{106}Rh, ^{137}Cs + ^{137m}Ba, ^{54}Mn, ^{238}U, ^{232}Th, ^{40}K) and the details of the analyser system used are tabulated. (UK)

57568 COSMOGENIC ^{22}Na IN SURFACE WATERS OF DRY LAND. Fleishman, D. G.; Kanevskii, Yu. P. (Inst. of Evolutionary Physiology and Biochemistry, Leningrad). Dokl. Akad. Nauk SSSR; 198: No. 6, 1397-1400(21 Jun 1971). (In Russian).

Of the cosmogenic radionuclides which are being formed in the earth's atmosphere, only ^{3}H and ^{22}Na are suitable for investigating hydrologic processes in nature. Rainfall and evaporation combined lead to an increase of ^{22}Na in surface waters as compared with that in atmospheric moisture. Rivers, as opposed to landlocked lakes, are discussed as regards the ^{22}Na content, and how the latter has been affected by the 1961 to 1962 nuclear explosions in the atmosphere. (K.S.W.)

57569 FISSION TRACK AGES AND URANIUM CONTENTS OF OBSIDIANS. Suzuki, Masao (Tokyo Univ.). Jinruigaku Zasshi; 78: No. 1, 50-8(Mar 1970).

The method of dating and measuring uranium concentrations by fission tracks is described and applied to a number of obsidians from known volcanic sources. Measured values of fission track ages and uranium contents of obsidians are given as a basis of the identification of geologic origins of obsidian artifacts from archaeological contexts. The usefulness of the method for this purpose is discussed. (auth) (Japan)

57570 MEASUREMENT OF URANIUM, THORIUM IN MANGANESE NODULES USING FISSION TRACKS AND ALPHA PARTICLE TRACKS. Yabuki, Hideo; Shima, Makoto (Inst. of Physical and Chemical Research, Yamato, Japan). Rikagaku Kenkyusho Hokoku; 47: No. 2, 27-32(Mar 1971). (In Japanese).

Induced fission track and alpha-particle track methods were used for measuring the uranium and thorium contents of four manganese nodules collected from the North and Central Pacific Ocean floor. Results for these four nodules are included in the range of 5 to 7 ppM for uranium and 18 to 32 ppM for thorium. Gamma spectrometric analysis performed for the same sample for comparison gave rather good agreement. By improving some points to cause errors, these methods could be adopted satisfactorily for determining uranium and thorium distributions in manganese nodules. (Japan)

57571 RADIOACTIVITY AND ELECTRICAL LOGGING TOOL COMBINATION. Winkler, John H. Jr. (to Schlumberger Tech. Corp.). U. S. Patent 3,566,682. 2 Mar 1971. Filed 22 Jan 1969.

An illustrative embodiment of the invention is directed to a combination sidewall radioactivity and electrical logging tool. One or more radiation detectors spaced from a source of radioactivity are housed within a skid that is urged against the borehole wall. A backup pad extending from the opposite side of the logging tool also is urged against the borehole wall. The working surface of the pad is formed of a tough electrical insulator that supports three vertically spaced electrodes. The electrodes are either flush with or recessed in the face of the insulator. This structural arrangement prevents the exposed electrodes from being short-circuited through the drilling mud or from being torn off the pad during operation. (Official Gazette)

Meteorology

Refer also to abstracts 57364, 57540, 57567, 57568, 57983, 57984, and 57990–57992.

57572 (COO–1340-24) RADIOACTIVE FALLOUT AND DISTURBANCES IN THE MID-LATITUDE WESTERLIES. Glasser, Marvin E.; Reiter, Elmar R. (Colorado State Univ., Fort Collins. Dept. of Atmospheric Science). Jul 1971. Contract AT(11-1)-1340. 37p. Dep. NTIS.

Surface radioactive fallout data for North America are compared with the meridional transport of momentum and with the shear characteristics of atmospheric flow in the lower stratosphere and upper troposphere. Cyclogenetic events during January 1964, their effect on radioactive fallout and on tropopause behavior are examined. (auth)

57573 (ORNL–4226) SIZE CLASSIFICATION OF SUBMICRON PARTICLES BY A LOW-PRESSURE CASCADE IMPACTOR. Parker, G. W.; Buchholz, H. (Oak Ridge National Lab., Tenn.). Jun 1968. Contract W-7405-eng-26. 64p. Dep. NTIS.

Aerosol particles in the submicron range are expected to be released as a consequence of a more or less severe core meltdown in reactor accidents. The behavior of aerosol particles is often explainable exclusively in terms of the laws of mechanics, which invariably include particle size as one parameter. Devices to measure particle size in the submicron region are therefore required; and a simple, passive, nearly foolproof device is particularly desirable. The principle of the cascade impactor is simple. A gas which is carrying particles is accelerated through a nozzle and impinged on a plate; particles having sufficient inertia (i.e. the large particles) leave the jet stream lines and settle on the plate. Successive stages with jets of increasing velocity remove successively smaller particles. Operation at low pressure increases the mean free path of the gas molecules and the Cunningham correction (for the slip of small particles between gas molecules). A cascade impactor of reasonable jet size which will separate submicron particles may be designed using these parameters. A commercially available (Andersen) impactor, modified for low pressure operation, and an impactor of original design were built, tested and calibrated. Design data and calibration curves are reported. The particle size range separated is from about 0.01 μ to several microns diameter. The original design impactor is assembled and disassembled very simply and employs throw-away impactor plates to facilitate decontamination. (auth)

57574 (PNE–524) OFF-SITE SURVEILLANCE FOR PROJECT SCHOONER, DECEMBER 8, 1968. Final Report. (Western Environmental Research Lab., Las Vegas, Nev.). Jun 1971. 91p. Dep. NTIS.

Project Schooner was a nuclear excavation experiment conducted at the Nevada Test Site on December 8, 1968, as part of the Plowshare Program. The results of the off-site radiological surveillance program performed for this event are presented. Aircraft observations soon after detonation indicated the top of the radioactive debris rose to approximately 19,000 feet above mean sea level. Aircraft and ground monitoring showed that the main cloud moved to the northeast across Utah and Colorado, while the base surge moved north into Idaho and then eastward across Montana and North Dakota. The highest external gamma exposure rate observed off-site was 350 mR/hr at 1100 hours PST on an azimuth of 54 degrees and at a distance of 44 miles from ground zero. The highest external gamma exposure rate observed at a populated location was 8.5 mR/hr at the Diablo Maintenance Station (33°, 47 miles) on Highway 25. The highest integrated external gamma exposure to an off-site resident wearing a personal dosimeter was 165 mR, received by a sheepherder from Uhalde's Ranch near Adaven, Nevada (45°, 75 miles), from December 8 through 17, 1968, while he was working several miles east of the ranch. The predominant radionuclide found in environmental samples was ^{187}W. The highest integrated ^{187}W concentration observed in air at a populated location was 12,000 μCi · sec/m^3 at Stickelman's Farm (357°, 55 miles) near Clark Station on December 8, 1968. The highest ^{187}W concentration in milk (9,100 pCi/l) was found in a December 9, 1968, sample from the Chavis Ranch (57°, 127 miles), north of Pioche, Nevada. The highest ^{187}W concentration (21,000 pCi/l) in a water supply used for human consumption was found in a December 11, 1968, sample from the Simpson's Ranch (42°, 75 miles) at Adaven, Nevada. The highest ^{3}H concentration in a water supply used for human consumption (2,800 pCi/l) was found in a December 11, 1968, sample from the Lotspeich Ranch (15°, 266 miles) near Deeth, Nevada. Iodine-131 was found in its highest concentration in milk (100 pCi/l) in a December 11, 1968, sample from the Boyd Schena Ranch (56°, 252 miles) near Abraham, Utah. The only other isotope of interest, ^{181}W, has been found in low levels in natural vegetation which has grown since the occurrence of the Schooner deposition, and in the muscles of cattle grazing in the deposition areas. Analyses of radiological data indicate that radioactive effluent arising from this event did not present any health hazard to the off-site population, based on presently accepted safety criteria established by the USAEC. (auth)

57575 (RA–42) GROSS RADIOACTIVITY IN AIRBORNE DUST. RESULTS OF MEASUREMENTS DURING 1967. van Dongen, R.; Moonen, H. P. M.; Wolf, H. J. (Rijks Instituut voor de Volksgezondheid, Bilthoven (Netherlands). Laboratorium voor Stralingsonderzoek). Apr 1968. 12p. Dep. NTIS (U. S. Sales Only).

Gross long-lived alpha, beta, and gamma activities of airborne dusts collected at De Bilt/Bilthoven, the Netherlands, during 1967, are reported. A short discussion of some results is given. (auth)

57576 RADIOAKTIVNOST' ATMOSFERY. Doklady na Simpoziume v g. Obinske 30 Iyulya–2 Avgusta 1868 g. (Radioactivity of the Atmosphere. Symposium Held at Obninsk, 30 July–2 August, 1968). Makhon'ko, K. P. (ed.). Trudy Inst. of Experimental Meteorology, No. 17. Moscow; Moskovskoe Otdelenie Gidrometeonzdata (1970). 132p. (CONF–680733).

Information on the products of nuclear explosions residing in the atmosphere and those that comprise eventual fallout on the ground is included. Radioactive fallout in the USSR during the interval 1963 to 1967, and airborne radioactivity in Prague are also discussed. Three papers were presented which deal with the natural radioactivity of the atmosphere in Budapest, Bratislaw, and throughout the USSR. The use of radioactive tracers to investigate mixing of air in the stratosphere and troposphere is also discussed. The last five papers consider methodology: sampling and measurement of aerosols; types of filters; and filter correction factors. (K.S.W.)

57577 RADIOACTIVE PARTICLES FROM THE EIGHTH CHINESE NUCLEAR TEST. **Persson, Gunnar; Sisefsky, Jan (Research Inst. of Swedish National Defence, Stockholm). Health Phys.: 21: No. 3, 421-8(Sep 1971).**

Debris from China's eighth nuclear explosion test was examined with γ spectrographic and autoradiographic methods. Nearly all of the debris was borne by submicroscopic particles, and "hot" particles, visible under the microscope (≥ 0.2 μm) were very rare. The few found were all nearly colourless spheres. Their specific β activity was the highest found so far. The largest particles are highly fractionated (especially mass-chain 141) but debris "in bulk" is not, as the gravitational separation between differently sized particles during the transport process is negligible. The difficulties in interpreting the fractionation factors of the hot particles as a reflection of the time between explosion and particle formation are discussed. If the particles are assumed to consist of Al_2O_3 and no mutual fractionation between Al and mass-chain 95 has occurred, the content of inactive construction material incorporated in the fire ball is estimated to be ~300 kg Al. (auth)

57578 RADIOACTIVE CERIUM FALLOUT AND HOT PARTICLES IN THE ATMOSPHERE. **Beck, James Noble. Fayetteville, Ark.; Univ. of Arkansas (1971). 89p. University Microfilms Order No. 71-19,534.**

Thesis

A study of the variation of the radioactive cerium isotopes in rain at Fayetteville, Arkansas, was carried out during the period between May 1, 1966, to December 31, 1968. The mean stratospheric residence time for ^{144}Ce was calculated and a value of 0.84 year was obtained for data collected in this laboratory since 1963. A fine structure was observed in the variation of the ^{141}Ce/^{144}Ce immediately after the third Chinese nuclear explosion of June 9, 1966, and the seventh Chinese nuclear explosion of December 24, 1967. This fine structure was explained as being due to the fact that the debris travels rapidly eastward and circles the earth a number of times. Long-range 500 mb and 300 mb air trajectories were computed in an attempt to interpret the daily variation of the number of fallout particles in the ground-level air observed at Fayetteville (36°N, 94°W), Arkansas, after a nuclear weapon was tested at Lop Nor (40°N, 90°E), China, on December 24, 1967. The dates of occurrence of peak concentrations of fallout particles generally coincided with the arrival times of air masses at 500 mg and/or 300 mb after completing a cycle around the world and the passage of 500 mb troughs at Fayetteville. (auth)

57579 RECENT FALLOUT OF RADIOACTIVE DUST IN JAPAN. **Miyake, Y. (Tokyo Univ. of Education); Katsuragi, Y. Tenki (Meteorol. Soc. Jap.): 17: No. 12, 593-8(Dec 1970). (In Japanese).**

The change of ^{137}Cs and ^{90}Sr fallout at eight localities in Japan from 1963 to a recent date was investigated. Recent nuclear weapon experiments by Communist China have been affecting the ^{90}Sr fallout in whole northern hemisphere, and their effects were estimated. The residence time of ^{90}Sr in the stratosphere, estimated from the amount of ^{90}Sr fallout from 1963 to 1966, is 1.3 to 1.4 years. Relations of the ^{90}Sr fallout in each locality in Japan with the amount of ^{90}Sr in the stratosphere over the northern hemisphere and with the ^{90}Sr fallout in the whole northern hemisphere are also discussed. The amounts of ^{90}Sr in the stratosphere over the northern hemisphere at the ends of 1967 and 1968 were 250 kCi and 200 kCi, respectively. The ^{90}Sr fallout in 1969 estimated from these values, is about 80 percent of that in the preceding year, and this coincides with the value 0.84 estimated from the ^{90}Sr fallout in the six localities in Japan. (Japan)

57580 DEBRIS OVER SWEDEN FROM THE CHINESE NUCLEAR WEAPON TEST SEPTEMBER 1969. **Sisefsky, J.; Persson, G. (Research Inst. of Swedish National Defense, Stockholm). Health Phys.: 21: No. 3, 463(Sep 1971).**

Debris from China's 10th nuclear test was air-sampled at 14 km over Sweden, and found to be very similar to that from China 8. Maximum debris (number of fissions per kg air) was found six months after the explosion and measurements are continuing. Debris was examined γ spectrographically and the $(n,\gamma)/(n,2n)$ ratio found to be 1.4; characteristic of a thermonuclear device. (UK)

Mineralogy and Exploration

Refer also to abstracts 57560, 57564, and 57867.

57581 ANALYSIS OF PROCESSES OF URANIUM REDISTRIBUTION AND DETACHMENT FROM ROCKS DURING THEIR PROGRESSIVE METAMORPHISM. **Ermolaev, N. P. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya; No. 8, 949-62(Aug 1971). (In Russian).**

Redistribution and detachment of uranium dispersed in rocks occurs during progressive metamorphism and ultrametamorphism of these rocks in processes of: recrystallization of sediments; desorption of uranium by aqueous carbonate solutions, which are formed during metamorphism; and rock transformation with removal of components—carriers of uranium (divalent bases, titanium) during granitization of sediments. Uranium removal from rocks is realized in a complex carbonate form or (under non-carbonate conditions) in association with the hydrometasilicate ion. (auth)

57582 ENHANCING BACTERIAL ACTIVITY IN A URANIUM MINE. **Duncan, D. W.; Bruynesteyn, A. (British Columbia Research, Vancouver). CIM (Can. Mining Met.) Bull.; 64: 32-6(May 1971).**

Acidic mine waters containing solubilized uranium were observed in many uranium and some copper mines. In every case, the sulfide and iron oxidizing bacterium, Thiobacillus ferrooxidans, was also present. This bacterium provides the ferric iron required to oxidize U^{+4}, both by oxidizing available ferrous iron and by oxidizing pyrite or other available sulfide minerals. This latter oxidation also provides sulfuric acid and may increase extraction by exposing more uranium. The enhancement of bacterial activity and the results of some field tests are discussed. (auth) (Canada)

57583 URAN V GRANITOIDAKH RAIONA GUL'SHAD TSENTRAL'NYI KAZAKHSTAN. **(Uranium in Granite in the Gul'shad Region, Central Kazakhstan). Ivanov, D. N. Leningrad; Izdatel'stvo Nauka Leningradskoe Otdelenie (1967). 80p.**

Elementary statistical methods were used to investigate the distribution of uranium in various types of granites from central Kazakhstan, USSR. This work showed the specific nature of U distribution in granites and explained how mathematical methods can be used to solve geochemical problems. The systematic study of granites showed that U is accumulated in acid intrusions and parallels the accumulation of potash and silicon. (tr-auth)

57584 SEDIMENTARY URANIUM DEPOSITS. **Robertson, David S.; Doublas, Richard F. (David S. Robertson and Associates, Ltd., Toronto). CIM (Can. Mining Met.) Bull.; 63: No. 697, 557-66(May 1970).**

Proterozoic quartz-pebble conglomerates contain about 60% of the known uranium reserves. These are all similar in appearance, in mode of distribution and in manner of origin. They carry uranium minerals and/or gold and abundant pyrite. Their unique distribution in Huronian time required a pre-existing crust well enough evolved to have plentiful quartz and abundant gold, uranium and pyrite. The materials of value were deposited as detrital heavy minerals prior to the appearance of an oxidizing atmosphere in late Proterozoic time. Epigenetic uranium deposits occur in arkosic sedimentary rocks through the entire geological column. About 30% of the western world's known ore reserves are in these rocks. This type of deposit is particularly prominent in semi-arid parts of the United States, having yielded most of the uranium ore produced and containing nearly all of the known reserves. The Western States type of deposits occur in lenticular, permeable stream-laid sedimentary rocks. The deposits are believed to have been precipitated from moving ground water at locations where plant debris or other organic matter had accumulated. The uranium may be derived from volcanic sediments, which are commonly associated with the units containing the ore, or it may be leached from exposed granite surfaces or from granitic debris which forms the sediments. A significant part of the world's uranium resources are in black shales and lignitic rocks. The lignites that contain uranium are virtually valueless as potential sources of heat. Uranium concentrations at levels such as to be potential sources of by-product uranium occur in many phosphorites. Reworked sediments may provide uranium in pegmatites and vein-like deposits. (auth) (Canada)

57585 ANOMALOUS ^{234}U/^{238}U ON THE EAST PACIFIC RISE. **Veeh, H. Herbert (Australian National Univ., Canberra); Bostroem, Kurt. Earth Planet. Sci. Lett.; 10: 372-4(Feb 1971).**

Data on the isotopic composition of uranium and thorium in sediments and iron deposits from the East Pacific Rise are reported and are used to support theories as to the origin of uranium in these iron-rich sediments. (L.C.L.)

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Oceanography

Refer also to abstracts 57409, 57410, and 57585.

57586 CONSTANT GEOMETRY APPROACH TO IN SITU SEABED GAMMA MONITORING. Reynolds, E. (Fisheries Radiobiological Lab., Lowestoft, Eng.). Health Phys.; 20: 241-51 (Mar 1971).

An in situ, temperature compensated, seabed gamma probe is described and the application and design philosophy discussed. Experimental results obtained in the Irish Sea are compared with results from seabed samples analyzed in the laboratory. The agreement between the two sets of data indicates the usefulness of the method for the rapid assessment of the intensity of the seabed gamma field arising from radioactive waste disposal. (auth)

57587 URANIUM GEOCHEMISTRY OF THE GULF OF MEXICO. Sackett, W. M.; Cook, G. (Texas A and M Univ., College Station). Trans., Gulf Coast Ass. Geol. Soc.; 19: 233-8(1969). (ORO-3852-2).

The economic importance, the dissimilarity in chemical behavior of its two oxidation states and the unique usefulness of its radioactive daughter products make uranium and its geochemistry extremely interesting to earth scientists. The Gulf of Mexico (GOM) has the attractive feature of being a semi-closed system that offers the possibility of a complete monitoring of all inputs and removal processes for trace elements such as uranium. Experimental values obtained in this study of the geochemical cycle of uranium in the GOM are given. High uranium concentrations in midwest U.S.A. rivers relative to other rivers of the world can be explained by solubilization of the uranium in phosphate fertilizers applied to the land surface. Estimated pre-fertilizer uranium input to the GOM is nearly balanced by uranium co-deposition with carbonates on the Yucatan shelf. (auth)

57588 QUESTION OF POSSIBLE VARIATIONS IN THE PAST CONCENTRATIONS OF URANIUM IN THE OCEAN. Kuznetsov, Yu. V. Sov. Radiochem. (Engl. Transl.); 13: No. 1, 113-19 (Jan-Feb 1971).

Translated from Radiokhimiya; 13: No. 1, 118-25(Jan-Feb 1971).

On the basis of experimental data on the vertical distribution of ^{230}Th and uranium in core samples of ocean sediments, the presence of an excess of ^{230}Th in the sedimentary core samples with respect to the amounts of it that should have been deposited from the column of water above the deposit was established. Working hypotheses explaining the detected phenomenon are presented. (auth)

Seismology

Refer also to abstract 57602.

57589 (CGS-746-12) EARTHQUAKES ON AND AROUND THE NEVADA TEST SITE, 1950-1971. King, Kenneth W.; Bayer, Kenneth C.; Brockman, Stanley R. (National Oceanic and Atmospheric Administration, Las Vegas, Nev. Earth Sciences Labs.). Aug 1971. Contract AT(29-2)-746. 32p. Dep. NTIS.

World seismic data files were searched for earthquakes that occurred within a 100 mi radius of the Nevada Test Site (NTS) during the period from 1950 to Aug. 1971. Since 1968 18 stations located near the NTS have monitored seismic activity in the area. Data showing the geographic location and magnitude of earthquakes and principal aftershocks for each year and information which relates the time of specific nuclear detonations and the date and location of earthquakes are presented. (L.C.L.)

57590 (COO-2138-4) AN INVESTIGATION INTO THE POTENTIAL SEISMOLOGICAL EFFECTS OF THE CANNIKIN EVENT. Willis, D. E.; Poetzl, K. G.; Saltzer, C. E.; Shakal, A. F.; Woodzick, T. L. (Wisconsin Univ., Milwaukee. Dept. of Geological Sciences). Sep 1971. Contract AT(11-1)-2138. 239p. Dep. NTIS.

The potential seismological effects of the proposed CANNIKIN underground nuclear shot at Amchitka are discussed. The main three areas of concern were considered to be the generation of a large natural earthquake by the shot, changing the regional seismicity pattern of naturally-occurring events, and the possible generation of a damaging tsunami. These studies indicate a very low probability that any damaging effects from the above would result from the CANNIKIN test. A statistical study of the Aleutian arc area indicates that there is a mean probability of 0.86% for a $M_s \geq 8.0$ earthquake occurring in the whole area in any given month and a 1.96% relative probability of a $M_s \geq 8.0$ earthquake occurring in the Rat Island/Amchitka area in any given year. (auth)

57591 (INIS-mf-71, pp 181-98) PROGRESS OF SEISMOLOGY IN INDIA. Tandon, A. N. (Bhabha Atomic Research Centre, Bombay (India)). 1970. (CONF-690730-1). INIS.

From Symposium on use of Gauribidanur data for seismological research; Bombay, India (4 Jul 1969).

Seismological developments in India from 1869 are traced. A description of the seismic array of the Bhabha Atomic Research Center at Gauribidanur is given. The Center has undertaken research in seismology directed primarily towards establishing more effective techniques for precisely locating underground nuclear explosions in time and space and to exploit the possibility of identifying such sources. (INIS)

57592 (JAB-99-70) APPROXIMATE PROCEDURE FOR DETERMINING BUILDING DYNAMIC RESPONSE CHARACTERISTICS. Raggett, Jon D. (Blume (John A.) and Associates Research Div., San Francisco, Calif.). Oct 1971. Contract AT(26-1)-99. 23p. Dep. NTIS.

An analytical procedure for determining the linear dynamic response characteristics of a building given a time history of the response of a point on the building and a time history of the ground motion is described. Modal characteristics are equated to those of a single-degree-of-freedom system which best fits the building response in a least squares sense. This best fit modal response is subtracted from the total response and the residual is treated in an analogous manner for the next most dominant mode. Two hypothetical and one actual building-ground time history pairs are analyzed using this procedure. Visual comparisons between actual and regenerated response time histories are made. (auth)

57593 (TID-25572) NUCLEAR-EXPLOSION SEISMOLOGY. AEC Critical Review Series. Rodean, Howard C. (California Univ., Livermore. Lawrence Livermore Lab.). 1971. 164p. Dep. NTIS.

Unclassified information that is pertinent to the generation of seismic signals by underground nuclear explosions, including the phenomena associated with decoupling and low-coupling techniques to minimize the seismic signals is summarized. These related topics are introduced with a review of the history of nuclear-explosion seismology and a general description of nuclear-explosion phenomena. The fraction of nuclear-explosion energy that is radiated in the form of seismic waves ranges from a few percent down to a few hundredths of one percent. This wide variation is a consequence of corresponding variations in the inelastic response of the material immediately surrounding the explosion. Some insight into inelastic-region phenomena is given by static-equilibrium solutions, but for an understanding of how explosions generate seismic waves, the dynamic process of inelastic-stress-wave propagation must be considered. Several theoretical and experimental examples of inelastic wave propagation, including a recent computer calculation of a 5-kt nuclear explosion in granite, are given. The physical principles of elastic-wave theory are summarized for three types of waves, P, S, and R, which are of predominant importance in differentiating between explosions and earthquakes. Other types of seismic waves are also generated by explosions and earthquakes, but this study is restricted to these three. The P or compressional waves are the first to arrive at distant seismic stations and are used in detection of seismic events. The R or Rayleigh waves, together with the P waves, are presently the most important with respect to identification of the event as an explosion or an earthquake. The S or shear waves are considered because, if R waves exist, P and S waves are also present. The discussion of P waves is more extensive than that for either S or R waves because much more theoretical and experimental information is available concerning the generation of P waves by explosions. Theoretical P-wave solutions are presented for both head and teleseismic varieties, with and without anelastic attenuation, as a function of explosion yield. Corresponding theoretical amplitude-yield curves for assumed seismometer-response functions are also presented. Available experimental amplitude-yield and magnitude-yield data for P waves are also given, and the observed effects of different geological environments, as well as cavities, on distant seismic signals are discussed. Concluding the review is a summary of what is and is not known concerning the generation of seismic waves by underground nuclear explosions. The greatest unknowns include accurate equations of state for rocks, especially for the process of adiabatic unloading, necessary for a complete description of inelastic-stress-wave propagation and the influence of various explosion parameters on R-wave characteristics. (auth)

57594 (UCRL-73369) CALCULATION OF SURFACE AND GROUND WAVES FROM ABOVE-GROUND AND UNDERGROUND EXPLOSIONS. Wilkins, Mark L. (California Univ., Livermore. Lawrence Radiation Lab.). 25 Aug 1971. 18p. (CONF-710918-1). Dep. NTIS.

From third international conference on gasdynamics of explosions and reactive systems; Marseille, France (12 Sep 1971).

The effectiveness of finite difference techniques for the study of wave and ground motions resulting from both above-ground and underground explosions is demonstrated. The accuracy of the calculational technique is established by a comparison with a selected problem that can be solved by other methods for the propagation of Rayleigh waves. Solutions are given for an explosion above the surface and for explosions below the surface. (auth)

57595 (USGS-474-112) VELOCITY CROSS SECTION 5, EXTENDING SOUTHWEST FROM TATUM DOME, LAMAR COUNTY, MISS. Eargle, D. Hoye; Black, R. A.; Davis, Beth O.; Stanford, J. F. Jr. (Geological Survey, Denver, Colo.). 1962. Contract AT(29-2)-474. 11p. Dep. NTIS.

Velocity cross section 5 extends about 18 miles southwest from Tatum salt dome, south-central Lamar County, Miss., to the northeastern part of Washington Parish, La. Cross section 5 shows major sonic velocity zones (and lateral variation of sonic velocity within these zones) for a region within a radius of about 25 miles of Tatum salt dome. Tatum dome is the site proposed for a series of seismic experiments (Dribble Project), for improving the detection of underground nuclear explosions. Data on sonic velocities of the sedimentary rocks surrounding Tatum dome are required for planning of instrumentation for recording the proposed seismic events and in the interpretation of the recorded seismograms. (auth)

57596 (USGS-474-129) STRUCTURE OF THE SOUTHEASTERN MISSISSIPPI REGION. Dribble-26. Eargle, D. Hoye; Stanford, John F. Jr.; Davis, Beth O. (Geological Survey, Denver, Colo.). 1971. Contract AT(29-2)-474. 23p. Dep. NTIS.

Logs of about 230 wells were analyzed and the data used to define the subsurface structure of the southeastern Mississippi region, an area of about 3,000 square miles in southeastern Mississippi and the northeastern part of Washington Parish, La. This subsurface structure was determined in order to characterize the lateral and vertical distribution of seismic velocities within the subsurface sedimentary rocks. The three-dimensional distribution configuration of the rocks is of interest in connection with Project Dribble at Tatum salt dome, Lamar County, Miss. Tatum salt dome is near the center and approximately 25 miles from the edges of this nearly square area. Structure-contour maps were prepared showing the tops of four lithologic units that are consistent sonic-velocity units. Isopach maps were prepared showing the thicknesses of selected stratigraphic units within the Cretaceous and Tertiary rocks. From a comparison of these maps some significant incidents in the geologic history and environmental conditions prevailing in the region can be reconstructed. (L.C.L.)

57597 EXPLOSION EFFECTS AND EARTHQUAKES IN THE AMCHITKA ISLAND REGION. Engdahl, E. R. (National Oceanic and Atmospheric Administration, Boulder, Colo.). Science; 173: No. 4003, 1232-5(24 Sep 1971).

Microearthquakes were monitored by a network of seismographs located on Amchitka and nearby islands; the nature of earthquake activity in this region was found to be consistent with the hypothesis of underthrusting of the Aleutian arc by a rigid lithospheric plate. Seismic effects of the nuclear explosion Milrow were small, of short duration, confined to the region immediate to the explosion, and were apparently independent of this geotectonic mechanism. (auth)

57598 EARTHQUAKE RESPONSE ANALYSIS OF NUCLEAR POWER PLANT. Muto, Kiyoshi; Uchida, Kazuyoshi; Inoue, Masasuke; Iwata, Yukio (Kajima Construction Co. Ltd., Tokyo). Kajima Kensetsu Gijutsu Kenkyusho Nempo; 18: 399-406(Oct 1970). (In Japanese).

Problems of damping and methods of simulating the earthquake response of BWR-type nuclear power plants are discussed. In earthquake response analysis for nuclear power plants, special attention must be paid to the simulation of the vibration model. If the structural behavior of each part of the nuclear power plant cannot be simulated correctly for earthquakes it is impossible to analyze earthquake response. As is well known in earthquake response analyses for ordinary buildings, almost any kind of conclusion may be reached at the stage of simulating the vibration model. Hence, even if calculations are made by a digital computer, the results may not always be satisfactory. Therefore, in order to obtain reliable results, it is necessary to use accurate information; that is, simulations must fit the conditions between vibration models and actual structure. By examining phenomena from both theoretical and practical aspects, it is possible to assess them more accurately, verifying information, and giving trustworthy calculation results. The dynamic system of nuclear power plants, consisting of buildings and equipment, is so complicated that it is hardly possible to work out a perfect idealization of the vibration model with current deficiencies in information. However, in view of the importance of nuclear power plants, more than cursory efforts must be made to create an accurate model. (auth) (Japan)

57599 P-WAVE SPECTRA FROM UNDERGROUND NUCLEAR EXPLOSIONS. Molnar, Peter. Geophys. J. Roy. Astron. Soc.; 23: 273-87(1971).

Observations are reported of P-wave spectra from underground nuclear explosions for periods greater than about 1 sec. The spectra have a maximum at about 2 to 3 sec and decrease rapidly at longer periods. Two phenomena could cause such a decrease: the surface reflection (pP), with its polarity opposite to that of the direct P wave, might differentiate the long-period signal and cause a modulation of $2|\sin \omega t_0/2|$ where t_0 is the interval of time between P and pP; or the source time function for the pressure on the boundary of the elastic zone surrounding the explosion might more nearly resemble an impulse than a step function as often assumed. The data are consistent with the simultaneous occurrence of both phenomena, but they are of insufficient quality or quantity to establish which is more important. If other information shows that the reflection does not have a large effect on the observed spectrum, then the data show that the source time function is primarily an impulse. In addition, the pronounced difference in spectral content of P waves from earthquakes and underground nuclear explosions suggests a method for identification that is applicable for explosions large enough to be recorded by long-period seismographs at teleseismic distances. This method may be particularly important when long-period instruments are disturbed by other events and methods of identification that rely on analysis of surface waves become inapplicable. (auth)

57600 DISCRIMINATION OF EARTHQUAKES AND EXPLOSIONS USING SHORT PERIOD SEISMIC ARRAY DATA. Anglin, F. M. (Dept. of Energy, Mines, and Resources, Ottawa). Nature (London); 233: No. 5314, 51-2(3 Sep 1971).

It is stated that, using data recorded at the Yellowknife short period seismic array in northern Canada, a simple two-divisional identification parameter was obtained that completely separated underground explosions at some Soviet test sites from shallow earthquakes within about 15° of these sites. Optimum discriminants were obtained both in the time and frequency domains. Extensive testing will be necessary to show whether this short period discriminant will apply on a worldwide basis or for larger event populations; if it does, it should provide a positive discriminant for explosions with yields <10kT in hard rock. (UK)

XUM

ENGINEERING

Nuclear Explosions

Refer also to abstracts 57523, 57562, 57563, 57574, 57580, 57589–57591, 57593, 57594, 57597, 57599, and 57600.

57601 (LMSC–D-177630(Vol.2)) STUDY OF NUCLEAR EXPLOSION SERVICES FIELDING SYSTEM. VOLUME II. SUPPORTING DATA (APPENDIXES A THROUGH H). Final Report, Phase II. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). 24 Jun 1971. Contract AT(26-1)-526. 351p. Dep. NTIS.

Volume II of the final report of Phase II of the Study of Nuclear Explosion Services Fielding System is presented and consists of the following eight appendixes: user explosive emplacement schedules; NES field personnel requirements; explosive transportation requirements data; control system; NES headquarters personnel and facilities requirements; system and subsystem evaluation methodology; cost models and cost data; and reference data. (L.C.L.)

57602 (SC-RR-69-376) GROUND MOTION PREDICTIONS FOR AMCHITKA. Merritt, M. L. (Sandia Labs., Albuquerque, N. Mex.). Jul 1969. 51p. Dep. NTIS.

Predictions of ground motion and underwater pressures from nuclear shots at Amchitka were made using Long Shot data against the background of Nevada experience. The ground motion data agree very nicely with data from previous shots in hard rock, but the underwater data can only be compared with theory, and the agreement is poor. Long Shot did not form a collapse crater but the larger shots in Nevada did, so that it is probable that large shots at Amchitka will also. Thus, a megaton device buried at 4000 feet is predicted to produce a surface zero acceleration of 24 g and a permanent displacement before collapse of 1.5 feet. Vertical accelerations will be above 1 g to a range of two miles. Overpressures in water will be above 300 psi to a range of 7000 feet. (auth)

57603 (TID-3522(Rev.9)) A SELECTED, ANNOTATED BIBLIOGRAPHY OF THE CIVIL, INDUSTRIAL, AND SCIENTIFIC USES FOR NUCLEAR EXPLOSIONS. West, Robert G. (comp.) (Division of Peaceful Nuclear Explosives (AEC), Washington, D. C.); Kelly, Robert C. (comp.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Sep 1971. 359p. Dep. NTIS.

This bibliography contains 1594 annotated references to reports and published literature on the USAEC's Plowshare Program. The references are arranged by subject category. Report Number and Availability, Author, Experiment, and Foreign Literature Indexes are included. (auth)

57604 (UCRL-73130) NUCLEAR CHIMNEYS: UNDERGROUND CONTAINERS FOR CHEMICAL AND METALLURGICAL PROCESSING. Lewis, A. E. (California Univ., Livermore. Lawrence Radiation Lab.). 26 Aug 1971. 32p. (CONF-711105–1). Dep. NTIS.

From Symposium on the underground environment; Washington, D. C. (3 Nov 1971).

It is practical to use contained nuclear explosions to construct underground openings (nuclear chimneys) under a variety of geologic conditions. The underground environment of these chimneys provides opportunities for the development of industrial processes that may not be practical at the earth's surface. Examples discussed are: the in situ, high-pressure, high-temperature recovery of metals from sulfide ores, and the in situ incorporation of nuclear-fuel reprocessing waste in molten silicate rock. (auth)

57605 GAS PRODUCTION BY NUCLEAR STIMULATION. Glass, Eugene D. (to Cities Service Oil Co.). U. S. Patent 3,566,966. 2 Mar 1971. Filed 26 Sep 1968.

Gases in the chimney of broken reservoir rock formed by the detonation of a nuclear device are withdrawn as quickly as possible following the detonation. The gases are pumped to another geologic horizon for disposal until the level of long half-life, gaseous contamination drops below the tolerable limits for such contamination. By withdrawing the contaminated gases from the chimney quickly, the pressure in the chimney at the time of withdrawal will be near that immediately after the nuclear explosion and will not have built up to values near the equilibrium pressure of the reservoir. The amount of reservoir gas contaminated with radioactivity and the consequent disposal problem are thereby minimized. Decontaminating processes at the surface to reduce the long half-life, gaseous contamination may be avoided. When the level of the long half-life, gaseous radioactive contamination falls below the tolerable limits for such contamination, the gases thereafter withdrawn from the chimney may be recovered as product gas suitable for processing and use. (Official Gazette)

57606 ESTIMATION OF NUCLEAR EXPLOSION ENERGIES FROM MICROBAROGRAPH RECORDS. Posey, J. W.; Pierce, A. D. (Massachusetts Inst. of Tech., Cambridge). Nature (London); 232: No. 5308, 253(23 Jul 1971).

An approximate theoretical relationship was developed between certain air waveform features from nuclear explosions and energy yield; this relationship is stated to be insensitive to changes in atmospheric conditions, such as average atmospheric temperature and wind profiles above the path connecting source to microbarograph, small changes in which appear to cause relatively large changes in the waveforms. The extent to which this relationship agrees with experimental data was examined. (UK)

57607 ANALYSIS OF JORUM CONTAINMENT. Crowley, B. K.; Glenn, H. D.; Kahn, J. S.; Thomsen, J. M. (Univ. of California, Livermore). Int. J. Rock Mech. Mining Sci.; 8: No. 2, 77-96(Mar 1971).

A pioneering calculational effort is described that dealt with problems relating to the stemming of an underground nuclear event before the event occurred. The Jorum Event presented two often-encountered situations: stemming of the main emplacement hole and stemming of a satellite hole. This event was unusual, however, in that portions of these holes were located below the water table. One- and two-dimensional, time-dependent, finite difference calculations that solved the conservation equations, with general equations-of-state and static and dynamic frictional forces, were used to simulate the two stemming situations. The models, assumptions and parameters used in the various calculations are discussed. Even when conservative parameters were used to represent the effects of water, the calculational results indicated that the planned stemming configurations would contain the event. (auth

Facilities and Equipment

Refer also to abstracts 57573, 57796, 58357, 58396, 58841, 58887, and 58938.

57608 (70-CNA-658) CANADIAN CENTRIFUGAL PUMP INDUSTRY: TWENTY YEARS OF DYNAMIC GROWTH. Meschino, J. L. (Borg-Warner (Canada) Ltd., Toronto (Ontario). Byron Jackson Div.). [1970]. 13p. (CONF-700564–13). Dep. NTIS (U. S. Sales Only).

From tenth annual international conference of the Canadian Nuclear Association; Toronto, Canada (24 May 1970).

Centrifugal pump manufacturing in Canada, particularly for the nuclear industry, is reviewed. In 1950 there was no fully integrated pump industry in Canada. Heavy pump equipment for refinery and process industries had to be imported completely or parts brought in for assembly only. By 1970 Canada could produce with its own labor and materials pumps for any industry including those required by power utilities, for nuclear or conventional thermal stations, regardless of size or horsepower. Specific pumping systems which have been built or which are under construction are described. (L.C.L.)

57609 (AED-C-1-18) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. Section 01: Civil Engineering. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). May 1971. 100p. (In English and German). Dep. NTIS (U. S. Sales Only).

A bibliography of 130 articles published from 1966 to 1971 on prestressed concrete pressure vessels for reactors is presented. The following indexes are included: author; report number; subject; source material, including regular publications, symposium reports, and individual reports. (L.C.L.)

57610 (BNL-50293) EXPERIMENTAL WORK IN THE BROOKHAVEN CHEMONUCLEAR IN-PILE RESEARCH LOOP. Beller, M.; Tucker, W.; Steinberg, M. (Brookhaven National Lab., Upton, N. Y.). Dec 1970. 58p. Dep. NTIS.

Chemonuclear processes making direct use of the energy of the nuclear fission process in producing industrial chemicals are discussed. Potential applications of these processes, such as production of ozone, fixation of nitrogen, and manufacture of carbon monoxide for pipeline gas, are described. Radiation and fission fragment chemistry data for these systems are summarized. The program of chemonuclear fuel development is described. The operational history of the chemonuclear loop is described, proceeding from initial dosimetry measurements to ozone synthesis from oxygen. The loop was installed in the Brookhaven Graphite Research Reactor. Budgetary restrictions prevented operation with chemonuclear fuel. The experiments were limited to the low-dose-rate neutron and gamma background radiation available from the Brookhaven Graphite Research Reactor. Despite this drawback, extremely encouraging results were obtained. Radiation yields (G-values) as high as 12 and ozone concentrations up to 500 ppM were achieved. This G-value compares favorably with the best yields obtained in carefully controlled laboratory experiments and was achieved in an all-metal, recirculating flow system (up to 425 csfm) with a high surface/volume ratio and at elevated pressures (up to 800 psi). The system was operated routinely by only two men and its operation was highly stable and reproducible. It was found that the addition of nitrogen enhanced the ozone concentrations obtained. It appears that at a given operating pressure, an optimum nitrogen concentration exists which results in maximum ozone concentration. The smooth operation of the chemonuclear loop and the high yields of ozone achieved represent an advance in nuclear technology and indicate that industrial chemicals can indeed be produced on a large scale by chemonuclear processes. (auth)

57611 (CTC-51) LABORATORY QUALITY CONTROL COMPUTER PROGRAM. Davis, M. H.; Hedge, W. D. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). 1 Oct 1971. Contract W-7405-eng-26. 121p. Dep. NTIS.

An IBM System/360 FORTRAN IV computer program is described which is used to process quality control data for the laboratory Division, Oak Ridge Gaseous Diffusion Plant. The program can be used to screen quality control data on the basis of tolerance limits, and then compute the statistical quantities necessary to assist the Laboratory in the quality evaluation of measurement methods. The statistical techniques used in analyzing the data are discussed. Program features are described, and operating instructions are provided. A detailed description of the input and output data is given. Examples of the types of output generated are presented. (auth)

57612 (HEDL-TME-71-114) CCTL MARK II SUBASSEMBLY SHIPPING PROCEDURE TESTING AND AND SHIPPING REPORT. Edgar, J. B.; Tillson, D. D. (Hanford Engineering Development Lab., Richland, Wash.). Aug 1971. Contract AT(45-1)-2170. 73p. Dep. NTIS.

The method of shipping a Mark II test assembly, mounted on Pimcore foam and tied down with nylon straps in an exclusive use air-ride moving van, is described and was adequate to maintain the average acceleration intensity at less than 0.2g's vertical. Occasional shocks greater than 1.5g occurred, but were not prevalent. Analysis of data from test #8—Shok Foam with nylon tie-down—should be made to determine if additional improvements in reducing vibration and shock are possible. (auth)

57613 (JAERI-Memo-4446) CONCEPTUAL DESIGN OF THE REACTANT FLOW LOOP FOR FISSIOCHEMICAL STUDIES. Kiyose, Ryohei; Sato, Shoichi; Moriyama, Noboru; Ishii, Toshio; Hirata, Mitsuho (Japan Atomic Energy Research Inst., Tokyo). May 1971. 46p. (In Japanese). Dep. NTIS (U. S. Sales Only).

A conceptual design of a gas flow loop has been made for dynamic fissiochemical reaction studies. Heat generation and reaction yields in the reactor section of the loop are estimated assuming the radiation fields of JRR-4 (Japan Research Reactor–4, swimming pool type, with 2.5 MW), together with the temperature distributions in the reaction vessels using external gas cooling in which cooling is done by a third gas flowing outside jacket of the vessel and alternatively using internal gas cooling in which vessel temperature is controlled by the reactant gas itself. Fission product activities are also evaluated. The flowsheet of the loop is prepared which has a helium cooling system for temperature control of the nitrogen reactant gas. The main structural component, iron, is heated mainly by gamma radiation at a rate of about 0.32 W/cm^3, and the nitrogen is heated mainly by fission fragment energies released within the reaction vessel. A vessel designed to contain 5 foils of 20% U–Pd alloy, 2.5 μ thick, 6 cm in width and 10 cm in length will be heated at a rate of 50 kcal/hr, and the reactant gas at 7.2 kcal/hr. The volatile fission products I + Xe + Kr will have a total activity of 1 Ci, after 20 minutes operation of the loop. A practical loop design is presented, based on the proposed power-up plan of JRR-4. (auth) (Japan)

57614 (KFK-1387) CHANGE OF INTERPRETATION OF THE INTERMEDIATE HEAT EXCHANGER FOR THE SODIUM COOLED REACTOR USING FERRITIC STEEL DESIGN. Schnauder, H.; Mueller, R. A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Mar 1971. 26p. (In German). Dep. NTIS (U. S. Sales Only).

A comparison of the economics of a sodium/sodium intermediate heat exchanger design using ferritic steel and one using austenitic steel is made. A program system was available for the investigation which carries out the most important strength calculations in addition to the thermal design. Under constant operating conditions, the influence of the diameter of the heat exchanger tube and the wall thickness on overall costs as related to building volume and heating area is investigated and represented in curves. The influence of various operating parameters on the total costs is shown for the optimum tube diameters selected. (auth)

57615 (LA-4746) QUARTERLY STATUS REPORT ON THE SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING JULY 31, 1971. PART I. (Los Alamos Scientific Lab., N. Mex.). Aug 1971. Contract W-7405-eng-36. 5p. Dep. NTIS.

Research and development progress is reported on heat pipe systems. Activities are summarized on tests of high-purity Li heat pipe, effects of impurities in heat pipes, and impurity removal methods. A method of constructing an in-pile test heat pipe is described. (J.R.D.)

57616 (LFEN-NI.-54-a) THERMODYNAMIC BEHAVIOR OF THE "MULTIFLASH" EVAPORATOR. Garcia, J. C. R.; Barros, Antonio A. S.; Costa, Augusto A. F. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1969. 31p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

The solution of the problem of partial charge stability and operation of multiflash evaporators was studied. Definitions and equations are derived. The degree of approximation in the various hypotheses is analyzed. Experimental models in the design stage are used in the calculations. (J.S.R.)

57617 (N-71-26910) BALL BEARING DESIGN FOR THE SNAP-8 TURBOALTERNATOR AND MERCURY PUMP. Foley, R. S. (Aerojet-General Corp., Azusa, Calif.). May 1971. Contract NAS5-417. 81p. (NASA-CR-72825). NTIS.

The design and application of angular-contact, tool-steel ball bearings used in the turbine-alternator and the mercury pump of the SNAP-8 electrical generating system are reported. These SNAP-8 rotating machines run on ball bearings with a design objective of 99.5% reliability for 10,000 hours of continuous operation. A summary of ball bearing operating experience through September 1970 is presented. The bearing design selected for operation in the SNAP-8 system has exceeded the original life objectives, and has operated in excess of 23,000 hours. From the experience gained to date, it is anticipated that bearing life of five years or greater is feasible. (auth) (STAR)

57618 (ORNL-TM-3570) FAILURES OF THREADED FITTINGS AND FASTENERS AT NUCLEAR FACILITIES. Scott, R. L.; Harley, P. H. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 19p. Dep. NTIS.

Thirty-three incidents are tabulated concerning problems encountered with bolts, screws, nuts, and threaded fittings, all of which should be of interest to both designers and operators. These incidents have required approximately 70 months of additional reactor downtime. One facility estimated an expenditure of $10,000 caused by the failure of a 1-in. threaded strainer plug. The three major types of failures, corrosion, fatigue, and galling, are discussed. (auth)

57619 (RFP-1739) INVESTIGATION OF FLUORINE INTERACTIONS WITH COMMON GLOVEBOX CONSTRUCTION MATERIALS. Meile, Louis J.; Wing, Ralph O. (Dow Chemical Co., Golden Colo. Rocky Flats Div.). 13 Sep 1971. Contract AT(29-1)-1106. 6p. Dep. NTIS.

The interactions between common glovebox construction materials and fluorine gas (F_2) were investigated to ascertain the potential safety hazards of handling high pressure fluorine within a glovebox system. Construction materials from volatile-fluoride, plutonium recovery gloveboxes at Rocky Flats Plant were tested in various fluorine and air mixtures at concentrations of 1 to 100 percent. All of the materials tested remained stable in fluorine concentrations of 10 percent, which is the calculated maximum anticipated in the event of a major fluoride release within the prototype gloveboxes. Many test materials spontaneously ignited in fluorine concentrations exceeding 25 percent. Combustion spread rapidly between close-proximity test samples in a fluorine atmosphere. Data reported are for static gas conditions at specified temperatures. Conclusions are given with a list of recommendations for use of fluorine within a glovebox system. (auth)

57620 (RISO-204) LOW-TEMPERATURE IRRADIATION FACILITY FOR HEAVY-ION RADIATION DAMAGE STUDIES

XUM

OF METALS. Andersen, H. H.; Simonsen, H.; Soerensen, H. (Danish Atomic Energy Commission, Risoe. Research Establishment). Mar 1971. 59p. Dep. NTIS (U. S. Sales Only).

A liquid-helium temperature facility for irradiation of thin metal foils with MeV protons, deuterons, ^{3}He, and ^{4}He was built in connection with the Tandem van-de-Graaff accelerator of the Niels Bohr Institute. The set-up includes a beam handling system (focusing devices and a beam sweep to create a homogeneous flux over the target area) and a liquid-helium cryostat with a built-in calorimetric dosimetry system (absolute accuracy 0.5%). Changes in electrical resistivity of the irradiated samples are measured with a superconducting chopper amplifier system with a dc sensitivity of 3×10^{-12} V and a relative reproducibility of 1 in 2×10^5. The performance of the facility is described in detail, and the data handling is discussed together with the necessary corrections to the experimental data. (auth)

57621 (TRG-Report-2141) ACOUSTICALLY INDUCED VIBRATIONS OF SLENDER RODS IN A CYLINDRICAL DUCT. VOLUMES I AND II. Hine, Michael John (Southampton Univ. (England)). Jan 1971. 185p. Dep. NTIS (U. S. Sales Only). Thesis.

The nature of acoustically-induced transverse vibrations of slender rods contained within a fluid-filled cylindrical duct was investigated for both single rods and rod clusters. The effect of low Mach number fluid flow on acoustically-induced rod response was also studied. (UK)

57622 SPECIAL VEHICLE FOR FIGHTING DAMAGES IN TERRAINS CONTAMINATED WITH ABC SUBSTANCES. Haas, Willy (to Daimler-Benz Aktiengesellschaft). U. S. Patent 3,567,273. 2 Mar 1971. Priority date 17 Nov 1965, Germany.

A vehicle is described for use in areas contaminated with atomic, biological and chemical substances or war materials, having a driver cab provided with built-in communication equipment and devices for determining radiation levels existing in the immediate environment of the vehicle, a center section having radiation-measuring apparatus and one or more devices for cleaning contaminated persons or objects, and a rear body section having water tanks, pumps and other necessary equipment. (Official Gazette)

57623 JET-MIXED LIQUID-LIQUID EXTRACTION COLUMN. Vermeulen, Theodore; Kahn, Daniel R. (to United States Atomic Energy Commission). U. S. Patent 3,574,558. 13 Apr 1971. Filed 6 May 1969.

A jet-mixed extraction column which incorporates the advantages of existing column-type extractors, while eliminating the need for internal moving parts is described. The column provides high rates of mass transfer, with only normal or even decreased extents of unwanted longitudinal dispersion compared to various prior column-type extractors. The column utilizes uniformly spaced, horizontal, tubular jetting and intake rings at the inner and outer boundaries of an annular cross-section. At each level, both rings are perforated so as to promote nearly straightline radial flow between the jetting and intake rings. Externally these rings are connected by way of a centrifugal circulating pump or a double-action reciprocating pump. (Official Gazette)

57624 PLUGGING COMPOUND COLLECTOR. Blair, Roy C. (to United States Atomic Energy Commission). U. S. Patent 3,554,374. 12 Jan 1971. Filed 2 Jul 1968.

A device is described for selectively extracting impurities from sodium coolant for subsequent analysis, identification and/or disposal. This is accomplished by arranging a battery of demountable, narrow sodium flow passages in a system where sodium temperature can be controlled. As sodium temperature decreases, any impurity will precipitate and collect on the flow passage walls when its equilibrium solubility is exceeded. The demountable arrangement of the device allows easy access to the collected material for removal and identification or disposal. (Official Gazette)

57625 IMPROVEMENTS IN OR RELATING TO IRRADIATION. (to Sulzer Brothers Ltd.). British Patent 1,230,950. 5 May 1971. Priority date 5 Dec 1968, Switzerland.

A method of irradiating articles is described in which the material to be irradiated is enclosed in a medium capable of combining with oxygen. The irradiation package is gas-tight and the materials are in contact with the contained gases during irradiation. Using this method, materials can be radiosterilized and deoxygenated simultaneously. (J.R.D.)

57626 K SERIES CENTRIFUGES (6 Jul 1971) (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn. Oak Ridge National Lab., Tenn.). (CAPE-1681(Rev.)). 28 drawings.

High-capacity zonal centrifuges in the K series are described. The K-II was designed for purification of influenza virus at a rate of ~100 liters/day making the instrument commercially feasible. The operating mode is continuous flow-with-banding using a tapered core with six vanes (similar to the B-IX core described in CAPE-1415). The rotor has a single path fluid-line seal at each end that eliminates the possibility of cross leakage between inlet and outlet streams. The air turbine drive is a modified commercial item. The K-XII zonal rotor is an improved K-II rotor, which eliminates the speed-dependent back pressure developed on the end and core caps by the K-II at a speed of 35,000 rpm. Seal leakage is also lowered. The incorporated improvements are applicable to all K-series cores and rotors. (For details see TID-4100 Suppl. 65). (F.S.)

57627 AUTOMATED CAMERA FOR HOT CELL METALLOGRAPHY. Bender, J. H.; Johnson, K. A. (Los Alamos Scientific Lab., N. Mex.). pp 19-23 of Proceedings of the Third Annual Technical Meeting of the International Metallographic Society, Inc. /Johnson, K. A. (ed.). Los Alamos, N. Mex.; International Metallographic Society, Inc. (1971).

From 3. meeting of the International Metallographic Society; Cleveland, Ohio (16 Nov 1970).

From third meeting of the International Metallographic Society; Cleveland, Ohio (16 Nov 1970).

Standard equipment modification and re-design permits the use of a viewing screen with a swing-out mirror in combination with a 70 mm roll film magazine. The associated electric shutters and timers, automatic film advance and integrated identification system are discussed. (auth)

57628 CONTROL OF AN INSTALLATION FOR THE IMPREGNATION AND GAMMA IRRADIATION OF WOOD. THE DEVELOPMENT AND PROGRAMMING OF A COMPUTER CONTROL SYSTEM. Silie; Worm; Taieb (Ecole Superieure d'Ingenieurs d'Electrotechnique et d'Electronique, Paris). Elec.-Electron. Mod.; 41: No. R251, 14-16; 27(Feb 1971). (In French).

The active part of the irradiator is divided into 5 parts, corresponding to the occupation of the irradiator by five different lots. Each time the first basket of a lot enters a new phase, the velocity is varied. The integrated dose is thus the sum of the five partial doses obtained with the successive velocities V1, V2, V3, V4, and V5. The computer must therefore control the treatment chain and the irradiation doses, and must perform the three following operations: calculation of the velocity associated with a given lot, calculation of the partial dose received associated with the velocity of the chain, and the calculation of the mean velocity associated with the velocities of the different lots. The order of magnitude of the voltages and resistances, the number of circuits necessary, and the read-out systems for the various parameters are studied. (France)

57629 AUTOMATIC ULTRASONIC INSTALLATION FOR DECONTAMINATION OF FOOTWEAR ON HUMAN LEGS. Vylezhnin, I. A.; Gol'dshtein, D. S.; Gorodinskii, D. S.; Kobylkin, A. F. (Moscow Inst. of Biophysics). Izotopy SSR; No. 17, 39-41(1970). (In Russian).

An ultrasonic facility for decontaminating footwear of personnel handling β- and β-γ active materials is described. The decontamination facility is highly efficient and prevents the possibility of contaminating the environment. (tr-auth)

57630 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS. Coles, Harold John (to Atomic Power Constructions Ltd.). British Patent 1,244,611. 2 Sep 1971. Filed 1 Dec 1967.

Reference is made to heat exchangers of the helical type, and the construction described is claimed to provide an exchanger that is easier and cheaper to assemble than some constructions previously used. This exchanger comprises a number of tubes, with transverse support members, and suitable attachment members. The support members are of elongated shape and are supported at at least one end, the tubes being arranged in parallel layers with support members between adjacent layers, and the attachment members of a layer of tubes are used to carry the support members of the next adjacent layer. The attachment members may take the form of suitable clips, and the tubes may be substantially in the form of helices fitting one inside the other. A number of alternative geometrical arrangements are described, together with constructional methods. (UK)

57631 PHYSICAL MEASUREMENTS ON A ^{60}Co IRRADIATION UNIT. Burlin, T. E.; Chan, F. K. (Polytechnic, London). Int. J. Appl. Radiat. Isotop.; 22: 73-83(Feb 1971).

The physical properties of a ^{60}Co irradiation unit were measured. Particular attention was paid to those aspects of the radiation field inside the radiation cell about which there is no information in the literature. The photon field has a large electron contamination, which would lead to an excess dose in the surface layers of irradiated objects. The photon energy spectrum is considered—about 20% of the photons in the irradiation cell arise from scattering processes. The exposure rate is measured by three methods and the exposure distribution presented. (auth)

57632 LEAK DETECTION IN SODIUM HEATED BOILERS. Hayes, D. J.; Horn, G. J. Brit. Nucl. Energy Soc.; 10: 41-8(Jan 1971).

Freedom from leaks in the sodium–heated boilers of a civil fast reactor cannot be guaranteed. Reliable procedures must be available so that the operator can detect, locate and isolate a leak with minimum interference to the running of the plant. Detection of a leak and isolation of the faulty unit should be achieved before the possibility of adjacent tube failure due to erosion. Analysis of available erosion data indicates that for $2\frac{1}{4}$ Cr–Mo material a leak as small as 100 μm dia could cause such a failure in a period of the order of 1 min. The design and performance of possible leak detection systems based on the detection of hydrogen in the sodium system are analyzed and discussed. (auth)

57633 MELCHETT LECTURE, 1970. THE FUTURE OF POWER GENERATION IN GREAT BRITAIN. **Allibone, T. E. (Central Electricity Generating Board, London).** J. Inst. Fuel; 44: 85-91(Feb 1971).

The pattern of growth of electrical generation and distribution, in Great Britain, during the next 30 yr is considered. Attempts are made to define the major changes in the balance of the fuels, coal, oil, gas, U, and H. The discussion includes a description of the growth and economics of nuclear power. It also envisages future prospects for thermonuclear devices, magnetohydrodynamics and the potential use of superconducting cables for power transmission. (UK)

57634 IMPROVEMENTS IN BEARINGS. **(to Messerschmidt-Boelkow-Blohm Gesellschaft Mit Beschraenkter Haftung). British Patent 1,245,894.** 8 Sep 1971. **Priority date 23 Apr 1968, Germany.**

A design is described for bearings of the kind in which a lubricant pressure support is utilized, the bearing, in use, being immersed in a lubricant bath, and the lubricant pressure being generated hydrodynamically in a wedge shaped gap between bearing surfaces of a body having a spherical bearing surface and a cup having a complementary bearing surface into which the body fits, the cup being provided with bores and grooves for the introduction of lubricant, and its bearing surface being divided by slits into segments which can deflect under load. Bearings of this kind are used for rotors turning on a vertical axis, such as ultracentrifuges, and often have to support the entire weight of the rotor, thus being subjected to considerable strain. This design results in a bearing which in use has a film of lubricant of reliable supporting capacity, which will not break up, formed between the bearing surfaces when moving at relatively high speed, which film will be maintained so that the supporting capacity of the bearing is improved, and its length of useful life increased, by comparison with known bearings. (L.C.L.)

57635 PRESSURE CELLS (8 Sep 1969) (Engineering Materials). **(California Univ., Livermore. Lawrence Radiation Lab.). (CAPE-2117).**
2 drawings.

Two pressure cells are described which are used in obtaining equilibrium thermodynamic data for liquid metals at high temperatures and pressures. A specimen of wire one mm in dia and 25 mm long is mounted between two current leads so that it is actually concentric with the cell. The cell is filled with He to the desired working pressure. A current pulse of controlled magnitude and duration, from the overdamped discharge of a high voltage capacitor bank, heats the wire to the desired state at a rate such that expansion is nearly isobaric. Energy deposited in a segment of the sample is calculated from data obtained by measuring the current through the sample and the potential difference between two probes spaced about 5 mm apart near the center of the specimen. From this collected data resistance is calculated. The thermodynamic specification of the high-temperature state is completed by measuring the expanded dia of the sample using x-radiographic techniques. Temperatures exceeding 5000°K at pressures up to 2 kbar have been reached with Pb. In the 3 kbar cell, construction is axial. The cell bottom is sealed with a steel plug that carries the plumbing required for gas transfer. Top and bottom seals are "O" rings that float between brass wedge rings and a 45° bevel on the opening in the Be cylinder. A Cu plug, through which three Cu leads pass, seals the top. These leads carry current to the sample and return voltage signals from the two voltage probes. Brass sample supports and current leads offer mechanical strength without sacrificing electrical conductivity. The top sample support is fitted with a notched end plate attached with a screw to securely clamp the sample and to provide electrical contact. The bottom support is cantilevered from a rod attached to the top plug of the cell to give support axially and symmetrically to the cell. Three Cu or tinned Cu rods extend downward into a plane through the axis of the sample. These rods are oriented with respect to two x-ray sources. The rods serve as calibration rods for the determination of the dia of the expanded sample. The cell is enclosed in a steel cylinder which provides rupture containment. Two major improvements are incorporated in the 7 kbar cell. The Be cell is supported by a steel sleeve. One inch square openings provide x-ray windows and a method for providing seal preload sufficient to maintain the seal is utilized. In the 3 kbar cell, pressure is provided by residual pressure in three reservoirs through appropriate valves and tubes. Pressures in the reservoirs are 1500, 5500 and 25,000 psi. An air driven oil pumping system is employed in the 7 kbar cell. This system supplies oil pressure for operating a seal-loading ram and an oil-gas separator. The pump can be connected to the ram, separator, and intensifier separately, thus making it possible to vary gas pressure and the seal load in incremental steps to achieve any desired pressure. (For details see TID-4100 Suppl. 66) (see also 25: 35342) (F.S.)

57636 FLUID IRRADIATING APPARATUS USING GAMMA RAYS AND HELICAL PASSAGEWAYS. **Mann, Leland A.; Woodbridge, David D.** (to Energy Systems, Inc.). **U. S. Patent 3,602,712. 31 Aug 1971. Filed 17 Feb 1969.**

A radioactive apparatus is provided for the sterilization and treatment of liquids and especially for the sterilization and treatment of liquid waste such as sewage and industrial waste by the use of gamma radiation sources. A spiraling input chamber spirals around a center chamber having an elongated core member with a helical pipe forming a helix or coil around said hollow member in the center chamber. Liquid waste being received by the apparatus passes through the spiraling chamber into the center chamber, into and through the elongated hollow member and then through the helical pipe to an output. Gamma radiation sources are located around the helical pipe in such a manner as to provide an efficient use of the radiation sources. (Official Gazette)

57637 DESIGN OF SAFETY VALVES AND THE LIKE FOR BWR-TYPE POWER STATIONS. **Ito, Mutsumi; Fujii, Takenori; Aoki, Tsuyoshi (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Karyoku Hatsuden: 22: No. 1, 59-64(Jan 1971). (In Japanese).**

The design of safety and relief valves attached to reactor pressure vessels, according to MITI regulation revised in 1970, is described. The regulation was revised so that in the case of equipment provided with overpressurization preventing devices, the capacity of the safety valves could be reduced. This means that the effects of a reactor scram on reduction of pressure can be taken into account. Therefore, in order to design total capacity of the safety and relief valves, it is necessary to analyze the transient state of plants following such disturbances as turbine trip with a dynamic characteristic model of the plants. The transient conditions analyzed for the design of the valves are as follows: while a turbine is running under heavy load, that is 105% of the rated output, the turbine is tripped but bypass valves do not operate and the turbine trip scram fails and overpressurization of a reactor vessel is controlled by the safety and relief valves. Other means to prevent the overpressurization considered is reactor scram by detection of high neutron flux or high pressure. Sharing of required capacity between the valves is engineered so that the high pressure spring-type safety valves never blow off in case of the overpressurization which is likely to happen frequently during plant operation. The conditions analyzed for the design of the safety relief valves are turbine trip, followed by reactor scram due to the turbine trip, with failure of the bypass valves to operate. (Japan)

Heat Transfer and Fluid Flow

Refer also to abstracts 57615, 57621, 57630, 57667, 57674, 58233, 58357, 60059, and 60222.

57638 (IAE-2014) HEAT EXCHANGE CRISIS DURING MOVEMENT OF BOILING WATER ALONG FUEL ROD BANKS. **Osmachkin, V. S. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).**

An analysis was made of the factors affecting the current conditions of heat exchange crisis in rod bundles. A formula is proposed for calculating the critical thermal loads in the fuel rod bundles generalizing the experimental data of various authors in a wide range of velocities, pressures, steam contents by weight at the channel output, and bundle lengths. (tr-auth)

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57639 (JUL–753-RB) HEAT TRANSFER OF TUBE SHAPED FUEL ELEMENTS OF THE CENTRAL CHANNEL OF A REACTOR OF THE TYPE NATURAL URANIUM-GAS-GRAPHITE. Broeckerhoff, Peter (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorbauelemente). Apr 1971. 106p. (In German). Dep. NTIS (U. S. Sales Only).

With respect to both heat and flow dynamics, design of tube-shaped fuel elements was studied which were cooled externally and internally and which were planned for a natural uranium-gas-graphite-type reactor. Equations were derived for calculating the cooling medium distribution between external and internal channels. Mathematical results were compared with experimental results on smooth and ribbed tube models. Various types of cooling ribs were tested. To assess the heating efficiency of tube-shaped fuel elements under typical reactor conditions, a special computer program was developed. Computations were performed for a fuel element of 9m length and with sine-wave shaped flux distribution. Because of limitations set by the cladding temperature, external and internal cooling ribs could remove only 3.5 times more heat than smooth tubes. The lowest pressure loss occurred with longitudinal internal cooling ribs, which had the additional advantage of lowest manufacturing cost. (H.B.G.)

57640 (N–71–22591) INDUCTION PLASMA NOZZLE TESTS. Poole, John W.; Vogel, Charles E. (Humphreys Corp., Concord, N. H. TAFA Div.). Apr 1971. Contract NAS3-13227. 48p. (NASA-CR–1765). NTIS.

An experimental program was conducted to establish induction coupled arc plasma systems with high exit gas enthalpies which could be used to study various nozzle designs. The objective of this work was closer simulation of the nozzle environment expected in the Gas Core Nuclear Rocket. Air plasmas with enthalpies up to 13,000 Btu/lb were developed and evaluation of transpiration-cooled and seeded-transpiration cooled nozzles was conducted. It was shown that transpiration cooling reduces the thermal load to the nozzle and the seeded-transpiration cooling further reduces the thermal load. (auth) (STAR)

57641 INTERACTIONS OF RADIANT ENERGY WITH SMALL PARTICLES IN HOT, HIGH PRESSURE GASES. Partain, William Lee Jr. Atlanta; Georgia Inst. of Tech. (1970). 165p. University Microfilms Order No. 71-6423.
Thesis.

Aerosols of submicron-sized refractory particles are being considered as coolants for gas core reactors and for thermal radiation shielding in nuclear rocket nozzles. In order to be useful for these applications, the particles should be strongly absorbing in the ultraviolet, visible and near infrared regions of the spectrum and should withstand high temperatures at high pressures without reacting or vaporizing. Submicron-sized particles of refractory metals generally satisfy both of these requirements. The ability of dispersed particles to absorb thermal radiation is determined by the extinction parameter, the scattering parameter and the angular scattering characteristics of the particles. Measurements are needed of these heat transfer parameters as functions of temperature, pressure, and incident radiant energy wavelength in order to evaluate the propellant heating in gas core nuclear rocket engines. Measurements of the extinction parameter of tungsten-hydrogen aerosols were made as a function of wavelength from 2500 to 5800 Å at pressures to 115 atmospheres and temperatures to 2500°K. High pressure hydrogen, first unseeded and then seeded, was heated in a furnace employing an electrically heated tungsten strip. Radiant energy from a high pressure mercury arc was passed through the furnace, and measurements of the transmitted radiation and of the aerosol density yielded the extinction parameter for the tungsten-hydrogen aerosol at the selected temperature and pressure. The measured extinction parameter at room temperature for all pressures to 115 atmospheres compared well with the theoretical value of the extinction parameter calculated using the Mie theory. The extinction parameter was observed to increase with pressure at temperatures above about 1000°K. Whereas the extinction parameter had been shown earlier to increase about a factor of two, from room temperature to 2000°K, at one atmosphere pressure, the increase was found to be about a factor of four at about 10 atmospheres and much greater at 100 atmospheres pressure. According to the Mie theory, the breaking up of particle agglomerates could account for part of this increase, but not all. Several physical processes are discussed that might be excepted to enhance photon extinction beyond that predicted by the Mie theory. (Diss. Abstr. Int., B)

57642 TRANSIENT FILM AND TRANSITION BOILING FROM A SPHERE. Stevens, J. W.; Witte, L. C. (Univ. of Houston, Tex.). Int. J. Heat Mass Transfer; 14: 443-50(Mar 1971).

The nature of transition boiling from $^3/_4$ in. dia copper sphere moving through subcooled distilled water was experimentally investigated. High-speed photographs show that transition occurs as a rapidly pulsating vapor film on the forward portion of the sphere. The behavior of the vapor wake is highly dependent upon the manner in which vapor is being formed on the forward portion of the sphere. Instantaneous heat transfer rates calculated from experimental temperature-time measurements indicate that film and transition boiling are as effective as nucleate boiling over the velocity range from 9.6 to 20.0 fps, in highly subcooled water. That is, there is no significant change in the heat transfer rate at transition as observed for free convection quenching of spheres.

57643 MEASUREMENT OF THE EFFECT OF TWISTED TAPES ON THE FORCED-CONVECTION HEAT TRANSFER AND BURNOUT IN HEAT EXCHANGERS. Brevi, R.; Cumo, M.; Palmieri, A.; Pitimada, D. (Comitato Nazionale per l'Energie Nucleare, Rome). Nucl. Sci. Eng.; 46: No. 1, 131-9(Oct 1971).

Very promising results with the insertion of twisted tapes in tubular heat exchangers have suggested performance of experiments under more interesting conditions, i.e., at higher pressures (50 atm) with exchangers of larger dimensions (200 cm in length and 1-cm i.d.). The results show a great increase in the forced-convection heat transfer coefficient ranging from 100 to 150% at specific mass flow rates of 70 to 100 g/(cm^2 sec). The law of dependence of the Nusselt number on the Reynolds number varies with an exponent unity instead of 0.8. The burnout thermal power increases by 30 to 50%; correspondingly, the burnout qualities increase from 60 to 90%, thus drastically reducing the post-burnout length. Furthermore, within this length there are no characteristic, dangerous temperature oscillations. The present results, together with others cited in the referenced literature, constitute a basis for improvement of the subcritical one-through heat exchangers for pressurized-water and liquid metal fast breeder reactor power plants. (auth)

57644 THERMAL CONTACT RESISTANCE BY REFLECTION OF HEAT DIFFUSION WAVES. Robinson, M. J.; Tomsic, M. (Kansas State Univ., Manhattan). Nucl. Technol.; 12: No. 4, 393-403(Dec 1971).

The applicability of the temperature wave method to thermal contact conductance measurements is investigated. The theoretical analysis shows that the amplitudes and the phase angles of the reflected and the transmitted temperature waves at the contact depend on the contact conductance, the ratio of the thermal conductivities, and the thermal diffusivities of the two solids. Measurements for stainless steel—aluminum specimen pairs confirm the theoretically predicted dependence. The accuracy of the method is comparable to that of the steady flow method. Since periodic heat flow and small temperature gradients are used the method has some advantages over the steady flow method and in particular some special features of contact conductivity phenomena may be studied. (auth)

57645 AIR FLOW THROUGH CONCENTRIC DUCTS SEPARATED BY A POROUS PIPE. Berger, F. P. (Queen Mary Coll., London); Blake, J. P. H. J. Brit. Nucl. Energy Soc.; 10: No. 3, 217-28(Jul 1971).

Experiments on air flow through concentric cylindrical ducts separated by porous pipes were carried out as a contribution to the assessment of porous fuel elements for the gas-cooled fast reactor concept. The experiments comprised measurement of the axial pressure distribution in both ducts, of the velocity in the axis of the inner duct, and of velocity profiles in the outer duct. A computer program describing the flow distribution in such a system was developed. When pressure recovery and pressure loss factors derived from the experiments were included in the program, the calculated flow patterns were in fair agreement with the experimental ones. (auth)

57646 IMPROVEMENTS IN OR RELATING TO FLOW PRESSURE MEASUREMENT. Davidson, Daniel Fraser (to United Kingdom Atomic Energy Authority). British Patent 1,234,210. 3 Jun 1971. Filed 2 Nov 1967.

Reference is made to methods for the measurement of liquid metal flow pressures, such as the delivery pressure of liquid metal pumps. The instrument described comprises a duct having low resistance to liquid flow, adapted for incorporation in the flow path. Means are provided for setting up a magnetic field across the duct, together with a pair of opposed electrodes for conduction of current generated by flow of the liquid metal through the magnetic field. The current induced in the liquid metal is circulated across the duct by way of a low resistance shunt between the electrodes, the electrical resistance of the shunt being substantially equal to the resistance of the liquid metal between the electrodes. Means are provided for measuring the potential difference between the electrodes, which is related to the liquid metal pressure. The low resistance shunt may be a Cu or Ag coating on the duct. (UK)

57647 BURN-OUT IN TRANSIENT BOILING HEAT TRANSFER. Sakurai, Akira (Kyoto Univ., Uji, Japan). Kyoto Daigaku Kogaku Kenkyusho Iho; No. 38, 1-14(Oct 1970). (In Japanese).

Transient boiling heat transfer and burnout are most important studies related to the safety analysis of reactor accidents. Burnout in transient boiling heat transfer is reviewed using previously published experimental data and theoretical analysis. First, critical heat flux and heat flux in departure from nucleate boiling is explained with a boiling curve. Secondly, from transient boiling experiment at Oak Ridge National Laboratory, the relation between the critical heat flux and the exponential period of heat flux at incidence of film boiling is presented, and then, analytical studies by various researchers are described. A new experimental apparatus for determining transient boiling burnout is proposed and principal experimental results are summarized. (Japan)

57648 VOID FRACTION MEASUREMENTS IN TWO-PHASE AIR-WATER FLOW IN A VERTICAL CHANNEL BY GAMMA RAY ATTENUATION. Siva Kumar, M.; Srikantiah, G. (Indian Inst. of Tech., Kanpur). Indian J. Technol.; 9: No. 4, 125-8 (Apr 1971).

The variation of void fraction and slip ratio with pressure and air weight fraction for the flow of a two-phase mixture of air and water in a vertical channel were measured by the γ-ray attenuation technique. The test section used was an aluminum pipe of square cross-section (3.33 cm^2). The pressure was varied in the range from 3.0 to 12.5 psig, and the air weight fraction in the range 0 to 3.6%. The void fraction was found to increase with pressure due to the sharp reduction in slip ratio. A scan of void distribution across the section showed that the voids have a tendency to concentrate near the center of the pipe. The experimental results were compared with those predicted. The agreement between the experimental and theoretical results is not satisfactory. Further analysis of the results indicated that the flow was in the bubbly regime, though the transition region was approached at higher values of void fraction. (auth)

Isotope Technology

Refer also to abstracts 57498, 57500, 57521, 57613, 57615, 57631, 57636, 57696, 57697, 57701, 57707, 58180–58182, 58242, and 59632–59640.

57649 (CONF-711002–, pp 1-9) PREPARATION OF NUCLEAR RESEARCH MATERIALS WITH A LABORATORY-TYPE ISOTOPE SEPARATOR. Lerner, Jerry (Argonne National Lab., Ill.). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Development of laboratory-type isotope separators is reviewed. A typical separator is described and it is noted that such separators are extensively used for process research materials for nuclear measurements because they can both purify the desired isotopes and also deposit them in the form required by the nature of the experiment. Applications include targets for cyclotron, Van de Graaff and synchrotron accelerators, sources for alpha, beta, gamma spectroscopy, Mössbauer studies, and optical pumping experiments. (J.R.D.)

57650 (CONF-711002–, pp 10-20) USE OF AN ELECTROMAGNETIC ISOTOPE SEPARATOR IN PREPARING SPECIAL RESEARCH SAMPLES. Alton, G. D.; Love, L. O. (Oak Ridge National Lab., Tenn.). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

The isotope separator was first used by the Europeans in the early 1950's in the preparation of thin, isotopically enriched accelerator targets, beta spectroscopy samples, and radioactive sources. Aside from the practical advantage of direct deposition, samples which are prepared in an electromagnetic isotope separator are generally of superior chemical and isotopic quality. The separator is also in increasing demand for use in modifying the chemical composition and physical properties of solid surfaces by implanting energetic particles into these surfaces. The isotope separator has been used to great advantage for doping semiconducting materials because the choice of dopants is no longer governed by the solubility limits or diffusion kinetics of the materials in question. The principal advantages of injecting dopants in this manner is in the preciseness in which uniformity, quantity of injected material, and depth of penetration can be controlled. In preparing samples for various uses in an isotope separator, the isotopic or elemental materials are collected directly; therefore, the limits of collection are controlled by the energy dependent, ion-surface interactions. In the keV energy range, the quantity of material per unit area is limited to the saturation value due to the fact that the self-sputtering ratio of the material is greater than one. If the quantity per unit area of material is to be increased, it is necessary to decrease the incident particle energy in order to permit the building up of layers. At this reduced energy, the efficiency of collection is governed by the value of the self-sputtering ratio and the probability that a particle will stick to the surface. Self-sputtering ratios, saturation values, and collection curves as a function of energy are used as fundamental guidelines in target and sample preparation with an isotope separator. Descriptions of the calutron system and the 180° ORSIS system are included. (auth)

57651 (CONF-711002–, pp 147-59) THIN FILM RADIATION SOURCES BY RADIOFREQUENCY SPUTTERING. Jarrett, J. H. (Battelle Pacific Northwest Labs., Richland, Wash.). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Preparation of thin film radiation sources by radiofrequency sputtering is described. Information and discussions are included on source design, source preparation, source properties, and source testing. A discussion of forecasted source developments is included. (J.R.D.)

57652 (DAISE–70-8) HEAVY WATER PRODUCTION, INDUSTRIAL PROCESSES, AND PLANTS. A Bibliography. Lavrencic, D. (comp.) (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1970. 314p. INIS.

The bibliography, covering the period from 1946 to June 1970, is arranged under the following items: General; Determination and Analyses; Production Processes and Fabrication Plants; Heavy Water Reactors; and Heavy Water Reactors in Nuclear Power Programmes. An author index is also included. (INIS)

57653 (DP–1270) HOT PRESSING TECHNIQUES FOR FABRICATING Cm_2O_3 FOR RADIOISOTOPIC FUEL FORMS. Rankin, D. T. (Du Pont de Nemours (E.I.) and Co., Aiken, S. C. Savannah River Lab.). Sep 1971. Contract AT(07-2)-1. 19p. Dep. NTIS.

Hot pressing techniques were developed for fabricating bulk oxide and oxide-refractory metal cermet fuel forms, using Gd_2O_3 as a stand-in for $^{244}Cm_2O_3$. High-density (95% theoretical) B-type oxide compacts were produced by pressing C-type oxide at 1200°C and then heating under pressure to 1300°C where the B-type oxide forms, or by direct pressing at higher temperatures (1500°C) in the B-type oxide range. High-density (>90%) cermet compacts containing 50 to 70 vol % oxide in tungsten or molybdenum matrices were also made by hot pressing. Most of the residual porosity for these structures was open and available for release of decay helium. (auth)

57654 (DP–1279) SAVANNAH RIVER LABORATORY ^{60}Co POWER AND HEAT SOURCES. Quarterly Progress Report, April–June 1971. Angerman, C. L.; Ross, C. P. (comps.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug 1971. Contract AT(07-2)-1. 19p. Dep. NTIS.

Satisfactory performance through 20,000 hr at 900°C was demonstrated with an Inconel 600 capsule containing unirradiated cobalt metal. Superalloys reacted slightly more with soil than with air during exposures at 1000 and 1093°C for one year. Satisfactory performance through 1000 hr at 1200°C was demonstrated with a tungsten capsule containing unirradiated cobalt metal. Results of additional oxidation tests of Nickel 200, which is similar to the Nickel 201 that is being used as the core material in the WANL 30 kW(t) Unit, indicate a slower oxidation rate than predicted from previous tests. A thermoelectric generator fueled with ^{60}Co continued to operate satisfactorily with an electrical output of 77 watts. (auth)

57655 (MLM–1844) NEUTRON EMISSION RATE REDUCTION IN PuO_2 BY OXYGEN EXCHANGE. Chadwell, C. B.; Elswick, T. C. (Mound Lab., Miamisburg, Ohio). 24 Sep 1971. Contract AT-33-1–Gen-53. 6p. Dep. NTIS.

A method was developed to produce $^{238}Pu^{16}O_2$ depleted in oxygen-18 and oxygen-17 on a routine production basis. The method is a gas phase-packed bed method which was used successfully on both low-fired and high-fired $^{238}PuO_2$ particles. Average neutron emission rates of 4.6 × 10^3 n/sec/g of plutonium-238 were obtained on production batches with average weights of 250 g plutonium-238. (auth)

57656 (N–71-18512) THERMIONIC ENERGY CONVERSION SYSTEM DESIGN. Final Technical Report. De Steese, J. G. (McDonnell Douglas Astronautics Co., Richland, Wash. Donald W. Douglas Labs.). Jan 1971. Contracts NAS7-100; JPL-952781). 193p. (NASA-CR-116795; MDC G–2024). NTIS.

For Jet Propulsion Lab., Pasadena, Calif.

System integrated performance characteristics are calculated

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for a new family of space power generators each consisting of a multicell array of low temperature, integrally-fueled radioisotope thermionic converters operating in the quasi-vacuum mode. Dominant variables, including the choice and influence of thermionic surface parameters, emitter geometry, fuel form, helium management, array reliability, system integration, and nuclear safety requirements are considered. Parametric study of plutonia-fueled multicell generators in the power range from 100 to 200 W(e) shows that system integrated specific power of approximately 4 W(e)/lb and overall conversion efficiencies in excess of 7% are achievable. This performance level is substantiated by a detailed 100 W(e) generator design. (auth) (STAR)

57657 (NUMEC-4189-6) RADIOISOTOPE POWERED CARDIAC PACEMAKER PROGRAM. Quarterly Progress Report for Phase II, May 1–July 31, 1971. (Nuclear Materials and Equipment Corp., Apollo, Pa. Energy Conversion Div.). Aug 1971. Contract AT(30-1)-4189. 32p. Dep. NTIS.

The results of developmental work on an implantable Radioisotope-Powered Cardiac Pacemaker (RPCP) are reported. Preparations for pilot production of RPCP's continued. All the fixtures and a complete tentative set of written procedures for such production were completed. During this report period two Phase I electronic circuits failed after 40 months of operation. In both circuits the failure mode was identical in that the output transistor developed an open emitter. Two preproduction nuclear batteries were assembled using essentially the materials and procedures presently intended for pilot production pacers. The performance of both units was significantly better than predicted. One of these units was placed on long term fatigue vibration testing. Recommendations were formulated and transmitted to the AEC on the fuel form to be used for the remaining heat sources required. Information and test data are presented on long term vibration testing, leak testing, elevated temperature testing of RPCP capsule with Pu metal fuel, life testing of experimental and prototype models, systems fabrication, and safety analyses. (L.C.L.)

57658 (ORNL-4723) ORNL ISOTOPIC POWER FUELS QUARTERLY REPORT FOR PERIOD ENDING JUNE 30, 1971. Lamb, Eugene (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 32p. Dep. NTIS.

Procedures have been developed with stand-in materials for fabricating cermets of varying fuel fractions which are permeable to helium and of high strength. These cermets are blends of metal and ceramic powders and can be produced by either hot-pressing or cold-pressing followed by sintering. Gadolinium is the stand-in for curium in the initial phase of process development for sized particles to be used in forming curium cermets. Rexyn 102H and Stratobed-84 ion exchange resins are being used in the study. Variables affecting density are being investigated to aid in obtaining a consistent high density. The most dense product was produced by loading the Gd_2O_3 onto Rexyn 102H. ORNL will fabricate the fuel pellets to be used in an accelerated $^{238}PuO_2$ fuel aging study. All parts of the CVD apparatus have been fabricated and are being tested. Experiments are being performed to determine phases present in $Cm_2O_3-PuO_2$ mixtures with Cm/Pu ratios of 0.03, 0.06, and 0.10. In order to eliminate or minimize pellet machining for this study, a trial hot-pressing with simulant was carried out in Al_2O_3-lined graphite dies and punches. Although densities of only 70% were obtained due to liner cracking, microprobe analysis revealed no diffusion of aluminum into the cermet. A miniaturized CVD coater system was designed and fabricated for molybdenum coating 5-g batches of $^{238}PuO_2$ and $^{242}Cm_2O_3-^{238}PuO_2$ powder. The CVD tungsten capsule was under test for 85 days at 1650°C when failure occurred. The characterization of Pt–Rh–W alloys is continuing. The effect of variations in the rhodium and tungsten contents have been investigated in order to determine the permissible limits. Only small changes in properties were obtained on alloys containing from 26 to 30% Rh and from 6 to 10% W. The compatibility of Pt–Rh–W with molybdenum and tungsten has been evaluated. An advanced version of this alloy containing small quantities of hafnium and titanium has been fabricated and shown to have a somewhat higher recrystallization temperature and slower grain growth rate which should permit its use to somewhat higher temperatures. Testing of tantalum alloys exposed to partial pressures of oxygen showed that Ta–10% W can dissolve as much as 1100 ppM oxygen without severe embrittlement while T-111 can only take something less than 750 ppM. However, a reentry heat pulse can ductilize T-111 containing up to 3000 ppM oxygen but will not help Ta-10% W. Catastrophic oxidation of T-111 in both pure oxygen and air has been discovered. After an incubation period of 2.5 hr at 800°C, T-111 has been observed to burn to powder. (auth)

57659 ISOTOPIC METHOD FOR DETERMINING THE EFFICIENCY OF EQUIPMENT FOR AGGLOMERATE PRODUCTION. Swigon, K.; Michalik, J. (Inst. fuer Kernforschung, Swierk, Poland). Isotopenpraxis; 7: No. 5, 167-71(May 1971). (In German).

The mixing efficiency of blast sintering plants for producing iron agglomerate was investigated using ^{140}La as a radiotracer. The method of labelling feed material is described. (tr-auth)

57660 STUDY OF THE COMPOSITION OF OXIDE COATINGS USING RADIOISOTOPES. Knyazeva, I. M.; Vasil'ev, V. P. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 5, 1031-4(May 1971). (In Russian).

A doubly labeled oxide coating on the cathode of a lamp was employed to measure losses during lamp operation. A ternary Ba, Sr, Ca carbonate mixture containing ^{133}Ba and ^{45}Ca initially formed the cathode coating which subsequently was degassed in a vacuum and dissociated to the respective oxides at an elevated temperature. The lamp was then opened and the cathode sectioned by a microtome into 10-μ layers for making radioassays. The ratio of Ba/Ca for a given section of oxide coating was determined as a function of the depth of the layer and also as a function of the time of operation of the cathode. It was found that a large Ba loss occurred during thermal dissociation and activation of the cathode. The emission characteristics and service life of the oxide coating depend upon the volatilization processes of the Ba component. (K.S.W.)

57661 ^{252}Cf NEUTRON SOURCE. Nagy, Arpad. Atomtech. Tajek.; 13: No. 8, 492-4(Dec 1970). (In Hungarian).

The ^{252}Cf source which has become available only recently presents many advantages over conventional neutron sources. It is a high-intensity compact system which does not require target material, thereby reducing the fabrication cost. A 10^9 n/sec source fabricated on a large scale was estimated to cost about $250.00 (without packaging and transportation). In the design of sources, the amount of helium generated by the (n,α) reaction must be taken into account when calculating the volume to be incapsulated. A 5×10^{10} n/sec $^{242}Cm-Be$ source generates 470 cm^3 of helium, while the ^{252}Cf source generates only 2 cm^3. The neutron spectrum of ^{252}Cf is similar to the fission spectrum of uranium. The theoretically highest thermal or fast flux to be produced by this type of source is estimated at 10^{12} n/cm^2 sec which is close to that of a 0.1 MW reactor. The neutron spectrum can be efficiently thermalized. (TTT)

57662 INVESTIGATION OF THE EROSION OF HIGH-PRESSURE [BOILER] FITTINGS BY THE USE OF RADIOISOTOPES. Vlasov, P. V. Teploenergetika; No. 12, 47-50(Dec 1970). (In Russian).

A method is described for investigating the erosion of the hard-facing of high-pressure boiler fittings using radioactive isotopes. Hard-facings of stainless steel 1Kh18N9T and Co stellite on low-C steel St. 2 were investigated using ^{50}Cr and ^{60}Co. (Metals Abstr.)

57663 SOME USES OF RADIOACTIVE ISOTOPES IN MEASUREMENTS ON TURBINES. Noltingk, B. E.; O'Neill, P. C. (Central Electricity Research Lab., Surrey, Eng.). J. Brit. Nucl. Energy Soc.; 10: 49-54(Jan 1971).

Two measurement techniques used on large steam turbines are described. In both, radioactive isotopes are used and both have the advantage that only robust, temperature-resistant components are placed inside the turbine. In one technique, relative movement between two parts under thermal expansion is measured by arranging that the degree of overlap between two slots is varied, thus varying the radiation escaping from a partially shielded source. In the other, the progress of blade erosion is monitored by observing the activity of a button mounted at an appropriate point. (auth)

57664 SPECIFICATION FOR GAMMA RADIOGRAPHY EXPOSURE CONTAINERS FOR INDUSTRIAL PURPOSES, AND THEIR SOURCE HOLDERS. British Standard 4097 1966. London; British Standards Institution (1966). 17p. Available from American National Standards Institute, New York.

A standard prescribing requirements relating to shielding containers for sealed gamma sources for use in radiography is presented. (W.H.K.)

57665 SPECIFICATION FOR GAMMA-RADIOGRAPHY SEALED SOURCES. British Standard 3513 1962. London; British Standards Institution (1962). 15p. Available from American National Standards Institute, New York.

A standard prescribing requirements relating to the supply of a range of sealed gamma sources for use in radiography is presented. The standard covers sources of activity up to approximately 100 curies for cobalt-60 or 300 curies for cesium-137 or iridium-192. (W.H.K.)

57666 STATE OF THE FUEL CYCLE INDUSTRY IN THE FEDERAL REPUBLIC OF GERMANY. Wirths, G. (NUKEM GmbH, Wolfgang, Ger.). Atomwirt., Atomtech.; 16: No. 8-9, 455-61(Aug-Sep 1971). (In German).

In the FRG, the fuel cycle situation is reportedly characterized by too small a market and too large an excess capacity, especially for the supply of natural uranium for the production of UF_6 and for reprocessing of spent fuel elements. Only in the area of hydrogen isotopes is economical production possible on a national scale. Pilot plants exist for plutonium manufacture and for the production of uranium-thorium fuel elements for high-temperature reactors. In the field of uranium enrichment, efforts include participation in the West-European gas centrifuge project and, on a national scale, development of a nozzle separation method. (tr-auth)

57667 MASS FLOW RATE MEASURING UTILIZING THE SCATTERING CROSS-SECTION OF A MATERIAL FOR FAST NEUTRONS. Hahn, Linus K. (to Industrial Nucleonics Corp.). U. S. Patent 3,577,158. 4 May 1971. Filed 7 Jan 1969.

Measuring the mass flow rate of a fluid having a high scattering cross section for fast high-energy neutrons by irradiating the material with such neutrons which are slowed to lower energy thermal neutrons and detecting the thermal neutrons downstream is described. For a more accurate determination of the mass flow rate, a second thermal neutron detector downstream has its output compared to the first detector output. Further, a gamma source and detector is employed to derive the density of the material and to obtain the velocity thereof by division of the mass flow by the density. (Official Gazette)

57668 α-RAY HEAT SOURCE, SUITABLE FOR USE IN A CARDIAC PACEMAKER. Barthelemy, Pierre; Boucher, Rene (to Commissariat a l'Energie Atomique). U. S. Patent 3,600,586. 17 Aug 1971. Priority date 9 Nov 1967, France. Filed 5 Nov 1968.

The heat source comprises a leak-tight container and a body of α-emitting material in the container. The material is an alloy of ^{238}Pu and of Sc, Ce, In, Ga, or Am in such proportions that the alloy is in δ phase. The container consists of an inner sheath of tantalum or tungsten and of an outer sheath of platinum. (Official Gazette)

57669 EXPERIMENTAL EVALUATION OF A RADIOISOTOPE-POWERED CARDIAC PACEMAKER. Morrow, A. G.; Levitsky, S.; Frommer, P. L.; (and others) (National Heart and Lung Inst., Bethesda, Md.). J. Thorac. Cardiovasc. Surg.; 60: 836-41(Dec 1970).

A radioisotope-powered pacemaker developed by the USAEC is undergoing studies in animals. The unit has a potential operating life of 11 to 20 years. The ^{238}Pu fuel serves as a heat source for direct thermoelectric conversion. Over 200 μW are available to the pacemaker circuit. The fuel is triply encapsulated and provided with thermal and radiation shields; there is insignificant heat and radioactivity externally. The evacuated, hermetically-sealed titanium case is the anode; the unipolar stimulating electrode (cathode) is connected via a ceramic-to-metal feedthrough. The unit weighs 100 g and is comparable in size to conventional pacemakers. Seven prototype units have been implanted in dogs for periods of up to 10 months. There have been no changes in rate or in the amplitude and configuration of the stimulus artifact. Pacing has been maintained continuously, except in 1 animal in which brief interruption apparently resulted not from battery failure but from a defective electronic component. Continuing studies are directed to the development of manufacturing methods which will permit the production of these power sources in quantity at acceptable cost and at the evaluation of these units. (auth)

57670 STUDY OF EFFECTIVE NONSYMMETRIC MULTICOMPONENT ISOTOPE SEPARATION CASCADES. Kolokol'tsov, N. A.; Sulaberidze, G. A. At. Energ. (USSR); 31: No. 3, 223-5 (Sep 1971). (In Russian).

A theory of optimal multicomponent nonsymmetric separation cascades is developed. It is shown that the maximum of effectiveness corresponds to the minimum of the function of $[1/\epsilon^2\theta(1-\theta)]$ where θ is the cut and ϵ is the coefficient of separation of a pair of isotopes with a unit mass difference. It is assumed that this condition obtained only for one specific class of multicomponent cascades but may be applied to all multicomponent cascades. (auth)

57671 ELECTRICAL POWER SYSTEMS FOR SPACE: ACHIEVEMENTS AND ISSUES. Miller, P. Rex (National Aeronautics and Space Administration, Washington, D. C.). Astronaut. Aeronaut.; 9: No. 8, 22-30(Aug 1971).

The development of electric power systems for space use from 1958 to 1971 is reviewed. Solar, radioisotope-fueled, and reactor systems are discussed. It is suggested that the development of radioisotope and reactor systems for powers in the tens of kilowatts should be encouraged, that a reactor power system for manned earth-orbiting missions can be achieved, and that these developments in space power technology will have spin-off benefits for terrestrial applications. (L.C.L.)

57672 RADIOAKTIVNYE IZOTOPY NA ZHELEZNODOROZHNOM TRANSPORTE. (Radioactive Isotopes in Railway Transportation). Toropchinov, A. N.; Tikhonov, G. M.; Kuznetsov, L. F. Moscow; Atomizdat (1971). 160p.

Radioisotopes are used in the railway operating industry for controlling wear of track parts, evaluating lubrication performance, measuring corrosion, etc. The equipment and methods associated with the use of radioisotopes are discussed. Technical-economic factors in the application of radioisotopes are analyzed, including capital investment, usable lifetime, and net costs. Safety features which are dictated by the use of radioactive sources are summarized, including shielding technology, dosimetry, and radiometric apparatus. 114 references. (K.S.W.)

57673 APPLICATION OF β-RADIATION EXCITATION OF X RAYS FOR THE INVESTIGATION OF DIFFUSION IN SOLIDS. Radwan, M.; Lutze-Birk, A. (Inst. fuer Kernforschung, Swierk, Poland). Int. J. Appl. Radiat. Isotop.; 22: No. 9, 561-5(Sep 1971). (In German).

It has been suggested that diffusion investigation could be carried out by layer analysis based on the measurement of x rays formed in the β-x process. There are two such methods; the measurement of k x-rays characteristic for a given element and the measurement of the high-energy content of the bremsstrahlung radiation spectrum. The second method was investigated using the diffusion of bismuth in copper. The method can be applied to all β-emitting radionuclides that diffuse in media of sufficiently high atomic number. (UK)

57674 APPLICATION OF THE TRACER METHOD IN INVESTIGATIONS OF EVAPORATION PHENOMENA IN POWER BOILERS. Lebecka, Jolanta; Lewczuk, Jacek; Wareda, Eugeniusz (Measurement and Testing Establishment Energoponiar, Gliwice, Poland). Nukleonika; 16: No. 3-4, 158-68(1971).

A method of measuring the degree of dryness of wet steam in water-wall tubes of power boilers is reported. For these investigations the boiler water was labeled with ^{186}Re. Measurements were made on a standard PK-230 boiler. The measurement principles and practice, and the method of interpreting the results are presented together with a brief description of apparatus and radiological protection used. The measurement error is estimated. The measurements of steam dryness were conducted alongside thermal and chemical measurements providing data on the evaporation process in the boiler tubes. Conclusions are drawn as to the scope of application of the method described. (auth)

57675 EXTENSIVE ENRICHMENT OF STABLE OXYGEN ISOTOPES BY COUNTERCURRENT DISTILLATION OF HEAVY WATER. Staschewski, Dieter (Kernforschungszentrum, Karlsruhe, Ger.). Chem.-Ing.-Tech.; 43: No. 14, 810-16(Jul 1971). (In German).

The construction and mode of operation of a distillation plant that permits isolation of pure oxygen isotopes starting from heavy water and using the same substance as a working medium are described. The process engineering problem of coupling a large number of individual columns was solved satisfactorily for the plant under consideration. Extraction rates for the isotopes ^{18}O, ^{17}O, and tritium were determined for previously enriched feed water. Time-based and local variations in the concentration profiles prevailing in the initial stage and in the ^{18}O main stage were followed quantitatively. (auth)

57676 SPECTRA AND CONVERSION FACTORS OF NEUTRON CALIBRATION SOURCES. Burger, G.; Eckl, W.; Gredel, H. (Institut fuer Strahlenforschung, Neuherberg, Ger.). pp 467-75 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The absolute output and spectra down to E_n = 700 keV have been measured for several standard neutron sources (AmBe, PuBe, AmF, AmB, ^{252}Cf). Spectral measurements were performed with organic scintillators. The principal features of the experimental technique and the method of data analysis are discussed. The measured spectra are compared with theoretical ones, the dose-fluence conversion factors are calculated and changes in these for different

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assumptions of the unknown low energy neutron spectrum are estimated. For some of the sources, leakage spectra from water moderators of varying sizes are calculated by a Monte Carlo code; the results are compared with measured leakage spectra and the corresponding conversion factors evaluated. The values for the unshielded sources decrease to about 70% when the sources are put into the center of a 12 in moderator. (auth)

57677 METHOD OF INVESTIGATING REFRACTORY WEAR IN METALLURGICAL FURNACES WITH RADIOACTIVE ISOTOPES. Skrebtsov, A. M. (Zhdanov Metallurgical Inst., USSR). Refractories (USSR) (Engl. Transl.); No. 9-10, 664-6(Sep-Oct 1970).

Translated from Ogneupory; No. 10, 52-4(Oct 1970).

Results of a study of lining wear in metallurgical furnaces showed that the possibility of diffusion of the isotope into the refractory structures must be considered. To reduce the radioactive-indicator diffusion into the refractory and improve the method of investigation, it is recommended that where possible, isotopes of heavy elements be used, and that ampules be used for eliminating or reducing the diffusion of the indicator into the refractory. (auth)

Materials Testing

Refer also to abstracts 57663, 57677, 57889, 58209, 58215, 58219, 58396, 59640, and 60142.

57678 (INR–1204) RADIOGRAPHICAL CONTROL OF THICKWALLED WELDS AND CASTINGS BY USING OF BETATRON. Janiczek, J.; Kielsznia, R.; Wolski, M. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 77p. (In Polish). Dep. NTIS (U. S. Sales Only).

The operating principles of betatrons are given and the problem of using betatrons for radiographic investigations is discussed. Experiments were performed using the Nuclear Research Institute betatron, and conclusions were formulated concerning the range of application of commercially available radiographic films to industrial radiographic control using betatrons. Some types of betatrons and betatron laboratories are described. (auth)

57679 (LB/G–2986) UNDERWATER NEUTRON RADIOGRAPHY, SURVEILLANCE OF ACTIVE IN-PILE TESTS. FIRST RESULTS WITH COLD-NEUTRON RADIOGRAPHY. Perves, J. P. Translated by R. G. P. Towndrow (Atomic Energy Research Establishment, Harwell, Eng.), from Sixth International Conference on Nondestructive Testing, Hanover, June 1st–5th 1970. 17p. (CONF-700613–4). Dep. NTIS (U. S. Sales Only).

The development of equipment and methods in France for neutron radiography of radioactive objects, particularly for underwater radiography of irradiated material in pool-type reactors, is described, and research studies with a reactor beam and with cold-neutron radiography are discussed. (L.C.L.)

57680 (ORNL-TM–3561) REMOTE INSPECTION OF WELDED JOINTS. McClung, R. W. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 16p. Dep. NTIS.

Maintenance and repair of reactor components by remote welding will require development of adequate nondestructive examination techniques to assure the integrity of the weld. High temperature and radiation levels will require remote inspections and add to the complexity of the performance. Recommended developments include improved closed-circuit television for visual examination, evaluation of new high-temperature penetrants, study of neutron radiography, improved transducers for ultrasonics, and application of acoustic emission and eddy currents. Sophisticated mechanical positioning, manipulation, and scanning equipment will be required for most of the techniques. (auth)

57681 SIMPLIFIED METHOD OF ANALYTICAL DETERMINING THE COEFFICIENT OF INCREASE FOR GAMMA RADIATION. Czarnecki, J.; Kowalik, S. (Military Tech. Academy, Warsaw). Biul. Wojsk. Akad. Tech.; 15: 139-50(1966). (In Polish).

There is a need for an effective method for determining the build-up factors for the usual measuring geometry for isotopes used in industry. An attempt to determine these factors was made experimentally. A ^{60}Co radiation source was used in an iron-shielded container. Geiger Mueller counters were used. On the basis of the absorption curves obtained by the measurements, a series of generalized formulas was derived defining the absorption coefficient as a function of such parameters such as the collimation, coefficient of the beam of gamma radiation, distance from the source, and distance of the detector from the absorbing layer. A theoretical generalization, worked out on the basis of experimental measurements, provides grounds for making an extrapolation of measurements and determining the permissible limits for changes of the parameters. The results of calculations are presented in a form of tables and diagrams. They provide the basis for determining the real absorption coefficient of the gamma radiation. (NSA of Poland)

57682 STANDARD METHOD FOR CONTROLLING QUALITY OF RADIOGRAPHIC TESTING. ASTM E142-68. Philadelphia: American Society for Testing and Materials (1968). 8p. Available from American Society for Testing and Materials, Philadelphia.

Standards are presented for controlling the reliability or quality of radiographic images produced during the radiographic inspection of materials. These standards cover the technique used, the equipment and film material used, safety, and the recording of data on the method and results. The number of areas or parts to be radiographed and the acceptance standard to be applied shall be specified. The quality level required for radiography shall be at least 2 percent (2-2T), unless a higher or lower quality is agreed upon by the purchaser and the supplier. (L.C.L.)

57683 STANDARD REFERENCE RADIOGRAPHS FOR STEEL WELDS. ASTM E99-63. Philadelphia: American Society for Testing and Materials (1963). 2p. Available from American Society for Testing and Materials, Philadelphia.

A collection of reference radiographs is presented which covers types and degrees of discontinuities occurring in steel welds that are detectable by radiographic methods. The reference radiographs are in the form of mounted transparencies and are intended to serve as a guide for radiographic interpretation. No attempt was made to establish limits of acceptability for any discontinuity. However, where applicable and upon agreement of all interested parties, they may be used in production inspection to evaluate weld soundness as provided for in product specifications. (auth)

57684 STANDARD REFERENCE RADIOGRAPHS FOR HEAVY-WALLED ($4\frac{1}{2}$ TO 12-IN.) STEEL CASTINGS. ASTM E280-68. Philadelphia: American Society for Testing and Materials (1968). 3p. Available from American Society for Testing and Materials, Philadelphia.

Reference radiographs are presented which are reproductions of original radiographs and are supplied as a means of establishing the categories and severity levels of discontinuities in steel castings that may be revealed by radiographic examination. They may be used in accordance with contractual specifications. Radiographs for evaluation are to be compared with these reference radiographs for classification on the basis of the category and severity level of the discontinuity. These reference radiographs are applicable to nominal section thicknesses of $4\frac{1}{2}$ to 12 in. (114 to 305 mm). (auth)

57685 STANDARD METHOD FOR ULTRASONIC CONTACT INSPECTION OF WELDMENTS. ASTM E164-65. Philadelphia: American Society for Testing and Materials (1965). 6p. Available from American Society for Testing and Materials, Philadelphia.

A procedure for ultrasonically testing and inspecting welds by the reflection method using pulsed waves introduced by direct contact of the searching unit with the weldment is specified. The procedure is basically a manual method for thicknesses over $\frac{3}{16}$ in. (5 mm). Specific variations for thin materials, automatic searching, and through transmission methods are not covered in detail, but where adaptable, the procedure may be used with these variations. The test is conducted using angle projection of the ultrasonic beam by surface contact, except where indicated otherwise in the method. In special cases, pulsed longitudinal waves can be used as described in the Recommended Practice for Ultrasonic Testing by the Reflection Method, Using Pulsed Longitudinal Waves Induced by Direct Contact (ASTM Designation: E 114). (auth)

57686 STANDARD METHOD FOR ULTRASONIC INSPECTION OF METAL PIPE AND TUBING FOR LONGITUDINAL DISCONTINUITIES. ASTM E213-68. Philadelphia: American Society for Testing and Materials (1968). 4p. Available from American Society for Testing and Materials, Philadelphia.

A method is described for detecting longitudinal discontinuities in metal pipe and tubing using pulse-reflection ultrasonic contact or immersion techniques. It is intended to be used for tubular products having outside diameters from approximately $\frac{1}{2}$ to 6 in. These techniques have been used for smaller and larger sizes, however, and may be specified upon contractural agreement by the purchaser and the producer. The characteristic oblique entry of sound into the tube wall and the circumferential direction of the sound path are illustrated. (auth)

57687 STANDARD REFERENCE RADIOGRAPHS FOR STEEL FUSION WELDS. ASTM E390-69. Philadelphia: American Society for Testing and Materials (1969). 4p. Available from American Society for Testing and Materials, Philadelphia.

Reference radiographs are presented which may be used to establish the types and severity levels of discontinuities that are revealed by radiographic examination. They may be used with contractual specifications. The three volumes of reference radiographs are based on seven nominal weld thicknesses and are applicable to seven thickness ranges up to 8 in. Each volume contains illustrations of representative graded and ungraded discontinuities. The discontinuity types and severities illustrated for each thickness of base material are listed. Each of the graded discontinuity types has five severity levels, 1 through 5 in order of increasing severity. The ungraded discontinuities are included for informational purposes. (auth)

57688 EQUIPMENT FOR THE X-RADIOGRAPHY OF RADIOACTIVE OBJECTS. J. Inst. Eng., Aust.; 42: 8(Jan-Feb 1970).

Equipment that will permit the x-radiography of many radioactive objects is described. The design aim was to reduce the intensity of the nuclear radiation without reducing the x-radiation intensity at the film, so that a satisfactory x-ray image may be formed. The following techniques were used: separation of the object from the film; shielding the film with a dense material except during x-ray exposure; use of a powerful x-ray source; and collimation between object and film. With the source on the axis of the radially slit rotating collimator, the x-rays from the source pass fully through all slits. However, the radiation from the object only reaches the film from those points on the object, and hence the object radiation at the film is reduced. (auth)

57689 RADIOGRAPHY APPLIED TO DETERMINING DYNAMIC CONDITIONS INSIDE AERO GAS TURBINES. Pullen, D. A. W. (Atomic Energy Research Establishment, Harwell, Eng.). Brit. J. Non-Destruct. Test.; 13: No. 2, 42-5(Mar 1971).

Two methods of radiography are described which were developed in collaboration with Rolls-Royce Ltd., Bristol Engine Division. The first method uses gamma radiography and is relatively inexpensive in yielding data on steady-state conditions on smaller engines. The second method uses an 8-MeV linear accelerator with very high output, (Vickers Super X) and yielded valuable data with short exposure times (4 to 5 seconds) through sections of 6 in. to 8 in. steel equivalent on the Olympus 593 for Concorde. Conditions approaching transients were successfully recorded. (auth) (UK)

57690 METAL INTENSIFYING SCREENS FOR RADIOGRAPHY. Ratcliffe, B. J. (Royal Armament Research and Development Establishment, Fort Halstead, Eng.). Brit. J. Non-Destruct. Test.; 13: 55-9(Mar 1971).

An investigation was carried out on the resolution and intensification factor of different metal screen combinations for high-energy radiography. It was found that with 5.5-MeV x-rays to obtain the best quality radiographs of fine detail, such as cracks, copper screens should be used with a front screen thickness of 0.06″ and with a very thin backscreen. A thin backscreen of 0.002″ is necessary to prevent spurious images from the backing felt or the packing cardboard in the cassette. As a compromise between thickness and convenience for handling, a copper back screen thickness of 0.010″ is suggested. The use of tungsten or silver screens is discussed but dismissed on cost considerations. It was shown that with ^{60}Co γ rays copper intensifying screens (0.020 to 0.080″ front, 0.010 to 0.040″ back) produced radiographs which had better resolution of detail than any combination of lead screens: the exposure-time needed to be double that required for lead screens. Metal intensifying screens for use with 1-MeV x-rays should be lead to obtain images of fine detail. The front lead screen should have a thickness of 0.06″ and the back lead screen should be approx. 0.05″ thick. Although screens of appropriate thickness of copper, tungsten and tantalum will produce almost equally good radiographs, there is little point in using any material except lead, as longer exposures will be necessary to obtain the same film densities. Also lead screens have the advantage of making it easier to maintain close contact with the film emulsion. (UK)

57691 POLAROID POSITIVE FILM IN NEUTRON RADIOGRAPHY. Hawkesworth, M. R. (Univ. of Birmingham, Eng.). J. Phys., E (London); 4: 400-1(May 1971).

Observations are presented of the density-exposure and reciprocity law failure characteristics of Polaroid Type 57 and Type 52 film when used in conjunction with NE421 and NE905 thermal neutron intensifying screens. The NE421–Type 57 combination proved to be the fastest radiographically and also has extremely good reciprocity failure characteristics, which makes it most useful for radiography with low intensity neutron beams. (auth)

57692 METHOD OF NONDESTRUCTIVE TESTING BY EDDY CURRENTS OF ELECTRICITY-CONDUCTING TUBES AND CORRESPONDING APPARATUS. Dufayet, Jean-Pierre; Dujardin, Roger (to Commissariat a l'Energie Atomique). French Patent 1,470,386. 3 Aug 1970. Filed 17 Oct 1968. 2nd Addition 95,394. (In French).

This addition to the main patent concerns a nondestructive method of testing electrically conducting tubes (in particular nonferromagnetic tubes and nuclear fuel pins). It is distinguished by the following points: the Hartley oscillator is electrically coupled to an alternating voltage generator and a given type of defect is detected by the resulting changes, according to the frequency of the voltage V supplied by the generator, in the grid voltage V_g of the oscillator triode and/or the voltage V supplied by the generator to the oscillator. The frequency of the alternating voltage supplied by the generator is varied cyclically within a frequency band extending on either side of the natural frequency of the oscillator and the displacements and deformations of the curve representing the variation against the frequency of the grid voltage V_g, and/or of the curve representing the variation against the frequency of the voltage V, are analyzed. A frequency is chosen in a zone where the sensitivity to the type of defect investigated is as high as possible and the sensitivity to other types of defect as low as possible, and the variations in the grid voltage V_g and/or in the voltage V are followed at this frequency. (auth) (France)

57693 TECHNIQUE FOR HOT CELL AUTORADIOGRAPHY. Jeffries, D. D.; Waldschmidt, L. A. (Los Alamos Scientific Lab., N. Mex.). pp 83-6 of Proceedings of the Third Annual Technical Meeting of the International Metallographic Society, Inc. /Johnson, K. A. (ed.). Los Alamos, N. Mex.; International Metallographic Society, Inc. (1971).

From third meeting of the International Metallographic Society; Cleveland, Ohio (16 Nov 1970).

A method is described for obtaining high quality alpha and beta-gamma autoradiographs from irradiated fast reactor fuel specimens. The method, which was developed for remote application in a hot cell, permits a high processing rate. Also described is the pneumatic system for assuring positive contact between the specimen and the films being used. (auth)

57694 STANDARD REFERENCE RADIOGRAPHS FOR STEEL CASTINGS UP TO 2 IN. (51MM) IN THICKNESS. ASTM E71-71. Philadelphia; American Society for Testing and Materials (1971). 2p. Available from American Society for Testing and Materials, Philadelphia.

Reference radiographs are presented which illustrate various types and degrees of discontinuities occurring in steel castings which have section thicknesses of up to 2 in. They are intended to provide the following: a guide enabling recognition of discontinuities and their differentiation both as to type and severity level; example radiographic illustrations of discontinuities and a nomenclature for reference in acceptance standards, specifications, and drawings; and a source of reference radiographs from which purchasers and suppliers may, by mutual agreement, select particular radiographs to serve as standards representing minimum acceptability. At the same time, the standards so established may be unambiguously identified by alphabetic defect type designation and severity level. Two sets of reference radiographs are provided herein. One set, made with 220 kV x rays, is intended for the evaluation of radiographs made with relatively low energy radiation, (x rays up to 400 kV and iridium-192). The second set, made with a radium source, is applicable to radiographs made with high energy radiation (1 and 2 MeV x rays, betatron x rays and cobalt-60 gamma rays). In each of these two sets, there are 31 radiographs which illustrate 7 different types of discontinuities of various severity grades or classes as in Table 1. (auth)

57695 STANDARD SPECIFICATION FOR STRAIGHT-BEAM ULTRASONIC EXAMINATION OF PLAIN AND CLAD STEEL PLATES FOR SPECIAL APPLICATIONS ASTM A578-71. Philadelphia; American Society for Testing and Materials (1971). 5p. Available from American Society for Testing and Materials, Philadelphia.

The procedure and acceptance standards are specified for straight-beam, pulse-echo, ultrasonic examination of rolled carbon and alloy plain and clad steel plates $^3/_4$ in. thick and over, for special applications. The method will detect discontinuities parallel to the rolled surfaces. Two levels of acceptance standards are provided. Supplementary requirements are provided for examination of clad plate and for alternative procedures. (auth)

57696 EVALUATING THE EFFICIENCY OF RADIOGRAPHIC QUALITY CONTROL. Akopov, V. S. Sov. J. Nondestruc. Test. (Engl. Transl.); No. 5, 557-9(Sep-Oct 1969).

Translated from Defektoskopiya; No. 5, 56-9(Sep-Oct 1969).

A method is discussed for evaluating the efficiency of radiographic quality control of articles. A criterion is offered for evaluating the overall efficiency, which determines the economic result of raising the articles' quality per ruble expended for this purpose. Using this criterion, one can demonstrate the value of introducing various control methods. (auth)

57697 OPTIMAL TIME OF USING A RADIOISOTOPE SOURCE OF RADIATION IN NONDESTRUCTIVE TESTING. Sul'kin, A. G.; Akopov, V. S.; Komarova, Yu. P.; Borisov, A. E. Sov. J. Nondestruc. Test. (Engl. Transl.); No. 2, 215-18(Mar-Apr 1970).
Translated from Defektoskopiya; No. 2, 102-5(Mar-Apr 1970).

A method is proposed for determining the optimal lifetime for a radioisotope source in relation to the complex of technical/economical aspects of nondestructive testing and recommendations for industry are given. (auth)

57698 DEVELOPMENT OF A METHOD OF NEUTRON RADIOGRAPHY OF MIXED OXIDE FUELS USING RADIOGRAPHIC ANALOGS. Dahlke, Lutz W.; Robkin, Maurice (Univ. of Washington, Seattle). Nucl. Technol.; 12: No. 4, 407-18(Dec 1971).

A high-resolution neutron radiographic system was developed for radiographing mixed-oxide particle fuels. The method was tested without fuel using TiO_2, Eu_2O_3 and RhO_2 mixtures as analogues for the oxides of U, ^{239}Pu, and ^{240}Pu respectively. These analogues have microscopic cross-sections similar to the fuel isotopes. Two wt % PuO_2-UO_2 fuel rod radiographic analogues were built containing PuO_2 analogue particle dia distributions from 0 to 800 μ. These radiographic analogues were radiographed with resonant energy neutrons using the activation transfer neutron detection technique to examine both the homogeneity of the mixed-oxide and the imaging of the various diameter PuO_2 analogue particles. A divergent neutron collimator was designed to successfully complete this study. Also, an experiment was performed to determine the contrast sensitivity of neutron radiography for the radiographic discrimination between the analogue for $^{239}PuO_2$ and the analogue for $^{240}PuO_2$. (auth)

57699 MASKED EDDY CURRENT PROBE (3 Aug 1971) (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-2122).
6 drawings.

A masked probe used in eddy-current detection of small closely spaced circumferential cracks in the 0.006 in. coatings of Rover fuel elements is described. The operating frequency of 8 M Hz will not penetrate the 0.006 in. thick brass mask, therefore, the probe signal is affected only by the small amount of material close to the slits of the mask. The outside dia of the mask is 0.084 in. The coil is wound of 0.003 in. dia wire and shaped to conform to the 0.073 in. ID of the mask. Eddy currents flowing along the axis of the bore are primarily sensitive to circumferential cracks. The coil, which has 50 turns, gives reasonable amplitude signals at 8 M Hz driving frequency and is not overly sensitive to capacity changes due to probe and cable movement. The electronics include the oscillator, isolation resistor, rectifier and filter, high-pass filter, adjustable-gain amplifier, non-linear response amplifier, two converters, and a recorder. The oscillator is a 10 Hz to 10 M Hz laboratory sine-wave generator. The isolation resistor causes the probe to operate in an effective constant current mode. The rectifier and filter change the varying amplitude probe signals to a varying dc voltage. The high-pass filter, which has a gain of 20 and a cut-off frequency of 3 Hz, filters out variations of the coating conductivity due to the temperature profile of the furnace. The adjustable-gain amplifier allows compensation for variations in the sensitivity of different probes. The non-linear response amplifier enhances the effect of small crack signals. The output signals of these two amplifiers are fed to a strip-chart recorder where a permanent record of the basic data is made. (For details see TID-4100 Suppl. 66) (see also NSA 23: 50084 and 25: 21257) (F.S.)

57700 DETECTION OF DEFECTS IN BUTT WELDS WITH BETA RAYS. Blinova, O. P.; Kreindlin, I. I.; Mashinin, V. A.; Terskii, R. V. Sov. J. Nondestruc. Test. (Engl. Transl.); No. 4, 378-82(Jul-Aug 1969).
Translated from Defektoskopiya; No. 4, 15-23(Jul-Aug 1969).

The use of β particles for radiography of thin welded joints is considered. Tests are reported for steel 0.7 to 0.8 mm thick with argon arc welds. It is concluded that the method is workable. The difficulties are discussed. (auth)

57701 DEFECT DETECTION IN GAMMA-SCINTILLATION NONDESTRUCTIVE TESTING. Kol'chuzhkin, A. M.; Uchaikin, V. V. (Tomsk Polytechnical Inst., USSR). Sov. J. Nondestruc. Test. (Engl. Transl.); No. 1, 74-80(Jan-Feb 1969).
Translated from Defektoskopiya; No. 1, 86-94(Jan-Feb 1969).

The energy dependence of the signal-to-noise ratio was studied by the counting and current detection methods for monoenergetic sources and a collimated detector. Scattered radiation spectra calculated by the Monte Carlo method were used to estimate the effects of the scattered radiation on the appearance of defects. Detection of defects in the current mode was calculated for the case in which a continuous spectrum source is used. (auth)

Protective Structures

Refer also to abstract 57592.

Radioactive Material Handling

Refer also to abstracts 57502, 57561, 57619, 57681, 58351, 59638, and 60212.

57702 (BNWL-B-112) SUMMARY REPORT ON ANALYSIS OF THE SEMI-FLUID CONDITION IN THE PG-6 PHOSPHATE GLASS SOLIDS CONTAINER. McElroy, J. L.; Mendel, J. E.; Roberts, F. P. (Battelle Pacific Northwest Labs., Richland, Wash.). May 1971. Contract AT(45-1)-1830. 30p. Dep. NTIS.

An 8-in. stainless steel pot was filled with phosphate glass in May 1968, placed in water storage, then placed in a controlled water environment, and removed in January 1969 for core drilling. In the top core drill hole a semi-fluid region was located within the center of the pot. A second core drill near the pot mid-plane revealed only a slight amount of fluid present, and a core drill near the bottom revealed no fluid present. It was found that thermocouple wells failed after the unit had been placed in the environmental test. Water from the storage pot entered through the failed thermowells and a boiling-refluxing action occurred within the pot that severely leached and degraded a portion of the product. (M.C.G.)

57703 (DPSPU-71-124-4A) SAFETY SUMMARY REPORT: SPERT-III FUEL IN PADUCAH DEMONSTRATION CASK (PACKAGING OF RADIOACTIVE AND FISSILE MATERIALS). Final Report. Scaggs, R. A. (comp.) (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Sep 1971. Contract AT(07-2)-1. 77p. Dep. NTIS.

Provisions for compliance with regulations concerning shipment of irradiated SPERT-III fuel from Idaho Falls, Idaho, to the Savannah River Plant, Aiken, South Carolina, in the Paducah Demonstration Cask which is shielded with depleted uranium are examined. The cask is 50.75 in. high inside and has an ID of 17 in. and an OD of 30 in. at the base of the fins which are 3 in. high. The wall consists of an inner stainless steel shell 0.25-in.-thick, 5.75 in. of laminated uranium, and an outer stainless steel shell 0.50-inch-thick. The cask with its fuel load weighs about 30,000 pounds. The shipments will include about 1556 fuel rods, containing UO_2 pellets with an active length of 38.3 in., and initial ^{235}U enrichment of 4.8%, and a SS cladding (0.466-in. OD by 0.020-in. thick). The total amount of UO_2 per rod is 910 grams. Aside from these rods, miscellaneous items, including smaller sound rods, failed rods, cut pieces, loose pellets, and powder having 3.1 to 10.6% enrichment and a total of not more than 2880 grams of ^{235}U, will also be shipped in stainless steel cans. (auth)

57704 (GULF-RT-A-10826) APPLICATION OF PHOTO-INDUCED REACTIONS TO NUCLEAR MATERIALS SAFEGUARDS PROBLEMS. Project Summary Report, July 1, 1970–June 30, 1971. Bramblett, R. L.; Costello, D. G.; Ginaven, R. O.; Gozani, T.; Hyde, A. T.; Naliboff, Y. D.; Rundquist, D. E.; Trimble, G. D. (Gulf Radiation Technology, San Diego, Calif.). 17 Sep 1971. Contract AT(04-3)-167. 151p. Dep. NTIS.

The research and development performed on techniques and application of nondestructive measurements of nuclear materials during the fiscal year July 1, 1970 to June 30, 1971 are described. During the fiscal year the Gulf Mobile Assay System (GAMAS) has been operated in the field under a wide variety of assay and weather conditions. Four locations have been visited in the states of California, Colorado, Missouri, and Idaho. The Idaho operation demonstrated the ability of GAMAS to provide assay equipment quickly when needed. GAMAS has been used to assay waste, scrap, and products of nuclear material containing low enrichment uranium, highly enriched uranium and plutonium. Sample containers ranging from quart to 55-gallon drums have been assayed. GAMAS operations at the field sites have clearly demonstrated the capability to accurately assay large containers with heterogeneous distributions of matrix and nuclear materials. It was shown that the majority of the nuclear waste generated at a nuclear facility can be assayed to an accuracy of ±15% or better, even in the large containers. Smaller containers with homogeneous quantities of nuclear material have been assayed to better than 1% under field operating conditions. Data acquisition and analysis methods have been described in conjunction with the Hewlett-Packard 2116B computer. The computer features completely automatic barrel scanning operation which is unique in the safeguards program. The Isotopic Source Assay System (ISAS), developed under the AEC Plant Instrumentation Program, is described. The ISAS, in conjunction with GAMAS, has demonstrated the applicability and versatility of this device as a nondestructive assay tool adaptable to many of the routine and nonroutine problems encountered in the nuclear industry. (auth)

57705 (MLM-1812) ATMX-500 RAIL CAR MODIFICATION. McDonald, E. P. (Mound Lab., Miamisburg, Ohio). 25 Aug 1971. Contract AT(33-1)-Gen-53. 21p. Dep. NTIS.

The development of a radioactive material container concept, the modification necessary to achieve a suitable container, and Mound Laboratory's experience in using this container are described. A modified ATMX-500 railroad car has been certified as meeting all applicable AEC and U. S. Department of Transportation (DOT) requirements and is currently being used under DOT Special Permit No. 5948. Particular emphasis is placed on the entire container concept since the present plans concerning the Salt Mine Repository in Lyons, Kansas, rely heavily on the use of these or ATMX-600 Series railroad cars. The report is intended to provide the basis for future modification of additional ATMX-500 cars to support the AEC plans for waste disposal. Procedural outlines, dimensional sketches and sequential photographs of the structural modifications are included to support this objective. Also included are the loading and shipping guidelines which were developed for effective utilization of these cars. (auth)

57706 (ORNL-TM-3545) CASK AND WASTE CONTAINER COOLING STUDIES. Holmes, J. M. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 22p. Dep. NTIS.

Digital simulation of an unsteady-state heat transfer system has been used to model the cooling of a cask containing cylinders of high-level radioactive waste solids prior to their removal from the cask at the National Radioactive Waste Repository in Lyons, Kansas. The recommended procedure involves, first, cooling the radiation shield of the cask with water (100 gpm) and, then, cooling the cask contents with steam. Dry steam (5000 lb/hr) is recommended for cooling of the cylinder walls to below 900°F in order to prevent excessive thermal shock to the metal. This would be followed by cooling with wet steam (5000 lb/hr, containing 40% moisture) which will reduce the average wall temperatures to less than 250°F. The procedure for cooling the radiation shield will require about 2 hr, while that for cooling the interior of the cask will require 5 hr. Air and helium were also considered for use in cooling the contents of the cask. (auth)

57707 IMPROVED PHOTOGRAPHIC LEAK TEST SYSTEM FOR SEALED SOURCES OF ^{226}Ra. Bedrosian, P. H.; Sensintaffar, E. L. (Public Health Service, Montgomery, Ala.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 112: No. 4, 788-91(Aug 1971).

An improved radon photographic method is described which is as rapid as other radium leak test procedures, is more economical, and offers more safety to personnel than many of the other techniques. Testing a 50 mg radium source by the photographic method usually involves less than 5 mr exposure to the hands when one foot or longer handling tools are used in performing the test. The device is portable and thereby useful for field applications. It may be connected to storage safes and calibrated for testing sources while they remain in storage. Leak testing of large numbers of sources by this technique may be safely done on a daily, weekly, or longer basis. (auth)

57708 RADIOACTIVE-WASTE DISPOSAL INTO THE SEA. Safety Series No. 5 1961. Vienna; International Atomic Energy Agency (1961). 174p. (STI/PUB-14). Available from UNIPUB, Inc., New York.

The IAEA ad hoc panel on radioactive waste disposal into the sea made a preliminary study of the possible contamination effects of such waste disposal by considering the magnitude of radioactive waste problems, the nature of the marine environment, maximum permissible exposure to radiation from radioactive waste disposal into the marine environment, and control measures. Recommendations, based on these studies, are offered which could serve as a basis for international agreement to ensure that any disposal of radioactive waste into the sea involves no unacceptable degree of hazard to man. Nine appendixes of technical information related to sea-disposal of radioactive wastes are included. (L.C.L.)

57709 SAFE HANDLING OF RADIOISOTOPES. FIRST EDITION WITH REVISED APPENDIX I. Safety Series No. 1 1962. Vienna; International Atomic Energy Agency (1962). 119p. (STI/PUB-1)(Rev. 1)). Available from UNIPUB, Inc., New York.

A guide to the safe handling of radioisotopes is presented. It is hoped that it will prove helpful particularly to small-scale users who may not have direct access to other sources of information. (auth)

57710 HAZARDOUS MATERIALS REGULATIONS OF THE DEPARTMENT OF TRANSPORTATION INCLUDING SPECIFICATIONS FOR SHIPPING CONTAINERS. Tariff No. 23 1969. Washington, D. C.; Department of Transportation (1969). 394p. Available from R. M. Graziano, Agent, Washington, D. C.

Regulations of the US Dept. of Transportation related to the shipping of hazardous materials by rail or highway are presented. Information is included on: individual US carriers affected; rulemaking procedures of the Hazardous Materials Regulations Board; restrictions covering the acceptance and transportation of explosives and other dangerous articles; itemized list of hazardous materials and the labeling required for shipping of each; specific requirements for rail freight, rail express, and rail baggage service carriers and for motor vehicle transport within municipalities and on public highways; and specifications for shipping containers and tank cars. (L.C.L.)

57711 CODE OF PRACTICE FOR CONVEYANCE THROUGH PORTS OF RADIOACTIVE MATERIALS. London; Ministry of Transport (1966). 25p. Available from British Information Service, New York.

A guide for the safe handling of all radioactive materials including fissile materials in ports, docks, and harbors in the United Kingdom is presented. (auth)

57712 AMERICAN NATIONAL STANDARD GUIDE TO SAMPLING AIRBORNE RADIOACTIVE MATERIALS IN NUCLEAR FACILITIES. ANSI N13.1 1969. New York; American National Standards Institute, Inc. (1969). 39p. Available from American National Standards Institute, New York.

A standard is presented which sets forth the principles that apply in obtaining valid samples of airborne radioactive materials, and prescribes acceptable methods and materials for gas and particle sampling. The scope of the standard is limited to the collection of samples and does not embrace the measurement of the radioactive materials collected. The scope is further limited to guides for sampling airborne radioactive materials in installations where work with radioactive materials is conducted, with the primary emphasis on the need to protect the radiation worker and includes sampling effluent gases prior to or at the point of release to the atmosphere from the installation. Although the scope thus excludes certain sampling techniques, such as some of those used in environmental and free atmosphere sampling, the principles defined and most of the methods discussed are in most cases generally applicable. (auth)

57713 DANGEROUS GOODS BY FREIGHT TRAIN AND BY PASSENGER TRAIN OR SIMILAR SERVICE. LIST OF DANGEROUS GOODS AND CONDITIONS OF ACCEPTANCE. B.R. 22426 (Revised) 1966. London; British Railways Board (1966). 244p. Available from British Information Service, New York.

Regulations of the British Railways Board for marking, packaging, handling, and transporting dangerous goods carried on freight or passenger trains are presented. These goods are categorized as: explosives, gases, inflammable liquids, inflammable solids, oxidizing substances, organic peroxides, toxic substances, infectious substances, radioactive materials, corrosives, and miscellaneous dangerous substances. (L.C.L.)

57714 USA STANDARD GUIDE FOR ADMINISTRATIVE PRACTICES IN RADIATION MONITORING (A GUIDE FOR MANAGEMENT). USAS N13.2 1969. New York; United States of America Standards Institute (1969). 15p. Available from American National Standards Institute, New York.

This standard provides guidance for the administrative practices associated with the monitoring of ionizing radiation in and about installations where there is a potential for radiation exposure. It considers the management aspects of an effective radiation monitoring program. (auth)

57715 PHYSICAL INVENTORIES OF NUCLEAR MATERIALS. ANSI N15.3 1971. New York; American National Standards Institute (1971). 7p. Available from American National Standard Institute, New York.

This standard specifies the minimum frequency for physical inventories and the fundamental steps which nuclear facility management shall take to ensure adequate physical inventories of nuclear materials. (auth)

57716 RECORD AND REPORTING UNITS FOR NUCLEAR MATERIALS CONTROL. ANSI N15.2 1971. New York; American National Standards Institute (1971). 4p. Available from American National Standards Institute, New York

The nuclear materials to which this standard shall apply include:

special nuclear materials such as uranium enriched in the isotope U-235 (subsequently referred to as "enriched uranium"), uranium enriched in the isotope U-233 (subsequently referred to as "uranium-233"), plutonium, and plutonium-238. This category shall be used if the contained isotope ^{238}Pu is greater than 10% of the total Pu element weight. Source materials are defined as uranium depleted in the isotope ^{235}U below 0.711 weight percent (subsequently referred to as "depleted uranium"), normal uranium; thorium; and tritium. This standard applies to records and reports of a facility which may reasonably be expected to be contributing to internal and external accountability. (auth)

57717 GUIDE TO PRACTICE NUCLEAR MATERIAL CONTROL SYSTEMS FOR CONVERSION FACILITIES. ANSI N15.4 1970. New York; American National Standards Institute (1970). 12p. Available from American National Standards Institute, New York.

This standard establishes requirements for control of nuclear material in conversion facilities. The basic materials to be converted include "yellow cake" or similar crude uranium compounds, uranium or plutonium oxides or nitrate, or uranium hexafluoride. The products of a conversion process include uranium hexafluoride, uranium or plutonium metal, uranium or plutonium oxides (chiefly UO_2 or PuO_2 or mixtures of these), or uranium or plutonium carbides, nitrides, etc. (auth)

57718 PLUTONIUM METAL CRITICALITY MEASUREMENTS. Hunt, D. C.; Boss, M. R. (Dow Chemical Co., Golden, Colo.). J. Nucl. Energy; 25: No. 6, 241-51(Jun 1971).

The results of a series of critical mass measurements on alpha-phase plutonium metal (5.9 wt % ^{240}Pu) are reported. The assemblies investigated were spheres and hemispheres either unreflected or reflected by combinations of steel and oil. The spherical critical masses are deduced from measurements on asymmetric spherical assemblies while the hemispherical critical parameters are obtained directly. Forty-two critical masses were measured. A description of the measurement techniques and experimental apparatus is given. The methods of data analysis together with the uncertainties due to the effects of the experimental apparatus are presented. Calculational estimates of the critical masses of hemispherical assemblies are made using a modified KENO computer code. Spherical assembly of calculations are done with the DTF code. Both codes make use of the 16 group Hansen–Roach neutron cross-section sets. The results of the measured and calculated critical masses are reported in tabular form. A comparison of the results from this work and that of other investigators is presented. (auth) (UK)

57719 STORAGE OF RADIOACTIVE SUBSTANCES. Patane, Michelangelo; Van Damme, Jacques (to EURATOM). British Patent 1,225,951. 24 Mar 1971. Priority date 12 Jan 1968, Germany.

A method for handling and storing radioactive substances is described which is comprised of a multiplicity of upright tubes or sockets in a concrete block, the mouths of the sockets, which face upwardly, being all at the same level and each being provided with a closure plug or cover, and a cell above the tubes providing screening against β and γ radiation and equipped with remote-control manipulators characterized in that the cell is in the form of a bottomless box with a base area smaller than the area occupied by the mouths of the tubes and is movable on rails over the area so occupied. (L.C.L.)

57720 SHIELDED SHIPPING CONTAINER (2 Dec 1970) (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE–2118).
7 drawings.

The design of a small cask for shipping up to 3 kg of fissile material such as whole or sectioned irradiated fast reactor fuel elements, associated hardware and components, and large quantities of other radioactive materials is presented. The cask meets the criteria for Fissile Class I shipments. Packaging consists of a steel encased right cylinder of depleted U that weighs ~2,000 lb. The cavity of the cask is too small to support criticality and an infinite array of containers are subcritical if loaded with any fissile materials. A drain with a fusible plug is provided. At a temperature of 100°F, contents of the container will be restricted to a maximum of 32 W thermal decay energy. The cask withstands 1475°F heat without melting. The worst damage condition resulting from a 30 ft free drop is plastic deformation of 1.41 in. on the outer edge of the container. The inner container is fabricated of 0.250 in. thick 304 stainless steel. (For details see TID-4100 Suppl. 66) (F.S.)

Vacuum Engineering

Refer also to abstracts 57297 and 57586.

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 57850, 57851, 57894, 57907, 57998, 58057, 58064, 58829, 59147, 59656, 59841, and 60046.

57721 (AECL-3989) GAMMA MONITOR FOR MEASURING ENVIRONMENTAL GAMMA DOSES AND DOSE RATES. Jones, A. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug 1971. 17p. Dep. NTIS (U. S. Sales Only). AECL $0.50.

A G–M monitor which permits estimation of gamma doses and dose rates at the low levels expected at the perimeters and surroundings of nuclear power stations and research laboratories. Dose rates are presented on a logarithmic scale 5 μrad/h to 5 mrad/h which can also be remotely monitored. Doses from 1 μrad to 10 rad are displayed on a register and can be measured over long periods (~1 year). The instrument is designed and calibrated to indicate the mean gonad dose absorbed by a population living in the vicinity. It can also be used for monitoring doses and dose rates to atomic energy workers in a low background (<6 mR/h). The monitor operates from line power, internal rechargeable batteries or solar batteries and is designed to operate in outdoor conditions of temperature and humidity. The design and performance of the monitor are described. An appendix gives circuit voltages, pulse heights and widths, and adjustments to aid in repair and manufacture. (auth)

57722 (CEA-R-4183) VERSATILE ANALOG DEVICE FOR IDENTIFYING CHARGED PARTICLES BY THEIR ENERGIES AND IONIZING POWERS. Harmanci, Ali Emre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971. 175p. (In French). Dep. NTIS (U. S. Sales Only).

The various methods of identification previously used are discussed; particular attention is given to a $\Delta E-E$ telescope. The usual approximations of the Bethe–Livingstone equation are examined, and a more universal formula is given. It is shown that, when this formula is applied to the case of light particles (p, d, t, ^{3}He, α), identification over a wide energy range is possible. The equipment operates logarithmically by using analog operators. The identifier possesses certain special features, especially concerning the logarithmic convertors and the base-line restorers. High accuracy, speed, and a good performance at high counting rates were achieved. Experimental results confirm the performance of the equipment and the validity of the formulas used. A large number of particles corresponding to $Z \leq 8$ were identified. (111 references) (auth)

57723 (CONF-711002–, pp 82-5) HIGH-TEMPERATURE NEUTRON DOSIMETERS. Joyeux, J.; Van Audenhove, J. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

In order to fulfill a need for high-temperature neutron flux measurements, preparation methods for Al_2O_3 + CoO (1% Co) and MgO + CoO (1% Co) activation detectors were developed, and compatibility with graphite-, Mo-, Al_2O_3- and MgO-contact materials up to 1500°C was investigated. (auth)

57724 (CONF-711002–, pp 86-90) PREPARATION OF NEUTRON DOSIMETERS FOR REACTORS. Box, W. D. (Oak Ridge National Lab., Tenn.). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

The standardization of activation detectors for in-core neutron flux monitoring is described. Size standardization and the preparation and use of ultrahigh purity vanadium as the encapsulating material are discussed, ^{10}B, ^{45}Sc, ^{232}Th, ^{235}U, ^{238}U, ^{237}Np, ^{238}Pu, ^{239}Pu, ^{240}Pu, and ^{241}Pu have been prepared. (W.H.K.)

57725 (KFKI-71-22) PROGRAM FOR THE DETERMINATION OF NEUTRON SPECTRA FROM ACTIVATION DATA. Fisher, A.; Turi, L. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [nd]. 33p. (In Russian). Dep. NTIS (U. S. Sales Only).

A method for unfolding neutron spectra from activation data is described. The code RFSP is an advanced version of the well known SPECTRA code. The program determines the spectrum which satisfies the activation equations and minimizes a quantity characterizing the deviation from the reference spectrum. Compared to SPECTRA, a typical run by RFSP requires much less time. The algorithm of the method and input/output specifications of the code are given. (auth)

57726 (STI/PUB-269) ADVANCES IN PHYSICAL AND BIOLOGICAL RADIATION DETECTORS. Proceedings Series. Proceedings of a Symposium, Vienna, 23-27 November 1970. (International Atomic Energy Agency, Vienna (Austria)). 1971. 756p. (In several languages). (CONF-701112). IAEA $21.00.

Separate abstracts were prepared for 58 of the 61 papers presented. The remaining three papers were previously included in NSA. (W.H.K.)

For abstracts of individual papers see: 57362, 57676, 57767–57782, 57822, 57823, 57833–57861, 58012–58019, and 58126.

57727 NUCLEAR-PARTICLE TRACK DETECTION USING LIQUID–LIQUID PHASE SEPARATION: THE GLASS CHAMBER. Srinivasan, G. R.; Younger, S.; Macedo, P. B.; Litovitz, T. A. (Catholic Univ. of America, Washington, D. C.). Contracts AT(40-1)-2854; N00014-68-A-0506-02. Phys. Rev. Lett.; 27: No. 16, 1084-6(18 Oct 1971).

A new technique is described for the detection of charged-particle tracks in glasses. The energy stored along the particle tracks is used to initiate heterogeneous nucleation of the second liquid phase. Track registration results are presented for uranium fission fragments using a sodium-silicate glass. (auth)

57728 NEUTRON DETECTOR. Rozenblyum, N. D.; Mitel'man, M. G.; Panasyuk, I. S.; Erofeev, R. S. Russian Patent 263,755. 10 Nov 1970. Filed 20 Nov 1967. (In Russian).

The described self-powered neutron detector consists of an emitter and a collector separated by a dielectric. The neutron flux parameters can be measured using this detector. (J.F.P.)

57729 ACTIVATION DETECTOR. Biryukov, E. I.; Novikov, V. T.; Khramov, N. N.; Shimanskaya, N. S. Russian Patent 274,241. 24 Jun 1970. Filed 22 Jul 1966. (In Russian).

An activation detector for the measurement of thermal neutron currents is described. This detector eliminates danger of radiation and neutron field deformation. (J.F.P.)

57730 GERMANIUM BASED SEMICONDUCTOR DETECTORS. Silar, Josef. Radioisotopy; 11: No. 2, 229-93(1970). (In Czech).

The assortment of germanium based p-i-n detectors produced and commercially available by the Institute for Research, Production and Uses of Radioisotopes is presented in graphs and tables. The final parameters of present spectrometers with germanium based p-i-n detectors are discussed on the grounds of literature studies and experimental experience. The requirements as to material and technology in the production of some types of detectors and the evaluation apparatus are briefly summarized. (63 references) (auth)

57731 DISCRIMINATORY DEVELOPMENT OF ALPHA PARTICLE AND PROTON RECOIL TRACKS IN TYPE K EMULSION LAYERS. Sheptulenko, E. V.; Skibenko, K. P.; Rutkevich, N. Ya. (Physical-Technical Inst., Kharkov). Zh. Nauch. Prikl. Fotogr. Kinematogr.; 16: No. 3, 220-1(May-Jun 1971). (In Russian).

The possibility of discriminatory development of tracks of α-particles and recoil protons in type K emulsion in 400 μ layers which were irradiated with 14 MeV neutrons is studied. The photographic developer, p-hydroxyphenylglycine, was introduced into the fixed layers without having first affixed the layers to a support. Directions are given for preparing the developer and fixing solutions and treating the exposed film for optimum results. (K.S.W.)

57732 DEADTIME CORRECTION IN COUNTING RAPIDLY DECAYING SOURCES. Porges, K. G. A.; De Volpi, A. (Argonne National Lab., Ill.). Int. J. Appl. Radiat. Isotop.; 22: No. 10, 581-6(Oct 1971).

The classical problem of deadtime correction with a fixed paralysis is treated for rapid decay during the counting period. Convenient correction formulae are developed for computing the input rate from the count, as well as for the variance attached to such calculations, in the presence of a quasi-constant background. (auth) (UK)

57733 GEOMETRIC FACTORS FOR ANGULAR CORRELATION MEASUREMENTS WITH GAMMA RADIATION. Grosswendt, B.; Waibel, E. PTB Mitt.; 81: No. 3, 159-71(Jun 1971). (In German).

XUM

The influence of shielding and spectral thresholds on angular correlation attenuation factors was measured for a $3'' \times 3''$ NaI(Tl) detector in the energy range of the gamma-radiation from 0.51 to 6.1 MeV. Remarkable discrepancies were found comparing the experimental results with calculated attenuation factors, based on the total γ-attenuation coefficients. In addition some tables of calculated factors are completed. (auth)

57734 PROCEEDINGS OF THE SYMPOSIUM ON SEMICONDUCTOR DETECTORS FOR NUCLEAR RADIATION, HELD IN MUNICH, 11–13 MAY 1970. Munich; Technische Universitaet (1970). 346p. (CONF-700527).

Separate abstracts were prepared for 27 of the 28 papers in this symposium. The remaining one, on the use of an x-ray detector in activation analysis, has already appeared as NSA 24: 41655. (R.W.R.)

For abstracts of individual papers see: 57735–57748 and 57797–57809.

57735 ORIGIN OF LITHIUM PRECIPITATION CENTERS IN GERMANIUM. Schell, K. J. Philips Gloeilampenfabrieken, Eindhoven, Netherlands). pp 1-8 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

Preferential etching of precipitated lithium in the n^+ layer of a Ge(Li) detector gives corroborative evidence that oxygen vacancy clusters act as nucleation centers. The same technique may also furnish information about the origin of such centers. (auth)

57736 PURIFICATION OF GERMANIUM CRYSTALS WITH A LEAD GETTER. Kegel, Gunter H. R. (Lowell Tech. Inst., Mass.). pp 35-43-43 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

The possibility of using lead as a getter for the purification of solid germanium is examined. It is concluded that lead is an effective getter for copper, nickel, and silver. It is less useful for cobalt and iron. (auth)

57737 CURRENT PULSE SHAPES OF SEMICONDUCTOR DETECTORS, MEASURED WITH AN AVERAGING TECHNIQUE. Fretwurst, E.; Grube, R.; Haken, N.; Mueller-Roos, J.; Andersson-Lindstroem, G. (Univ., Hamburg). pp 44-61 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

A method for measuring the current pulse shapes of semiconductor detectors by using an averaging technique (sampling oscilloscope and signal averager) is described. The effects of bias voltage and direction of bombardment are investigated. The influence of radiation damage on the detector output at different bias voltages and temperatures is reported. (R.W.R.)

57738 DETERMINATION OF CARRIER-MOBILITY AND LIFETIME IN p–i–n DETECTORS FROM THE RESPONSE TO MODULATED LIGHT. Bernt, H.; Eichinger, P. (Institut fuer Technische Elektronik, Munich). pp 70-8 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

The mobility and lifetime of charge carriers in p–i–n detectors were determined by a method based on the response of the detectors to sine-modulated light. This method is suitable for the determination of mobility and its dependence on the electric field strengths. Trapping and detrapping parameters may be found with relatively little experimental effort. The method is less suitable for an investigation of field profiles since the photocurrent is calculated from an integral over the field region. (R.W.R.)

57739 TEMPERATURE DEPENDENCE OF THE AVERAGE ENERGY PER ELECTRON–HOLE PAIR IN GERMANIUM. Stuck, R. (CRN, Strasbourg); Siffert, P.; Ricaud, C. pp 79-90 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

Ge(Li) detectors irradiated with γ rays in the temperature range 20 to 120°K were used to determinate ϵ as a function of E_G, where ϵ is the average energy expended for the creation of an electron–hole pair and E_G is the bandgap energy. A linear relation was found. (R.W.R.)

57740 FULL-ENERGY PEAK EFFICIENCY CALIBRATION OF A WELL-TYPE Ge(Li) GAMMA-RAY DETECTOR. Verplanke, J. C.; Verheijke, M. L. (Philips Research Labs., Eindhoven, Netherlands). pp 91-100 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

The full-energy peak efficiency of a 51-cm^3 Ge(Li) well-type detector was determined by means of reference standard solutions of nine different nuclides. The sources, which had a volume of 1 ml, were placed in the well of the detector. As gamma cascade-emitting nuclides were also used, in order to cover the whole energy range up to 2 MeV, corrections for summing effects were carried out. (auth)

57741 RECTIFYING PROCESS IN SURFACE BARRIER DETECTORS. Torreiter, A.; Siffert, P. (Laboratoire de Physique des Rayonnements et d'Electronique Nucleaire, Strasbourg). pp 107-18 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

Present understanding of the physical processes underlying the rectifying mechanism of the metal–semiconductor surface-barrier diode is summarized. For a given metal the surface potential is largely independent of temperature and of the doping level of the base material, but it depends on the ambient atmosphere. An equilibrium is reached in a time determined by the kinetics of the chemical reaction, rather than by the carrier transit time through the oxide layer. The surface potential is then given by the electrochemical potential of the chemical species present. Such a physicochemical model is completely opposite to Schottky's theory. (R.W.R.)

57742 SPECTRAL NOISE INTENSITY OF SILICON DETECTORS. Feigt, I.; Jaentsch, O. (Siemens AG, Erlangen, Ger.). pp 180-7 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

Measurement of the spectral noise intensity of silicon detectors is discussed. The noise of such detectors originates primarily at the surface. It has $1/f$ (mainly) and $1/f^2$ character up to frequencies of nearly 10^6 Hz, and can be strongly influenced by changing surface conditions. Measurements on diffused and Li-drifted Si detectors are presented. The diodes have good proportionality between the noise current and the reverse current; however, some have an exponential increase of the noise. (R.W.R.)

57743 EXPERIENCE WITH SEMICONDUCTOR DETECTORS AS DOSIMETERS IN A CLINICAL ENVIRONMENT. Parker, R. P. (Inst. of Cancer Research, Sutton, Eng.). pp 221-34 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

The use of silicon diodes for clinical dosimetry is discussed. Those factors that go into the choice of detector parameters and the associated electronic equipment are considered. The advantages and disadvantages of these detectors and their routine use are reported. (R.W.R.)

57744 MINIATURIZED NEEDLE-TYPE SEMICONDUCTOR DETECTORS FOR IN-VIVO MEASUREMENTS OF TRACER ACTIVITY. Lauber, A. pp 235-52 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

A set of miniature detector probes for measurement of beta and gamma tracer activity in vivo is described. The probes use a lithium-compensated p–i–n silicon detector as sensing element. The standard "needle probe" contains a cylindrical detector 0.9 mm in diameter and 3 mm long, enclosed in a stainless steel tube 1.1 mm in outer diameter and with walls 50 μm thick. For particular applications several modified types were developed: probes with larger sensing elements, probes with extra-thin walls for low-energy beta detection, probes with two or three sensing elements in the same needle, and probes containing a movable sensing element. (auth)

57745 TECHNICAL AND PHYSICAL DETAILS ON MANUFACTURING AND IN VIVO APPLICATION OF MINIATURIZED SEMICONDUCTOR DETECTORS. Linhart, G. (Univ., Giessen, Ger.);

Allwein, M.; Pfeiff, H. pp 253-62 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

Miniaturized semiconductor counters of n-silicon used for measurements in vivo are examined. Improvements in the areas of mechanical stability, better surface protection, and geometrical design are presented. Characteristic behavior under expected conditions is demonstrated. (auth)

57746 DESIGN CRITERIA OF RADIATION RESISTANT SEMICONDUCTOR NEUTRON DETECTORS. Graul, J. (Technische Hochschule, Munich). pp 270-83 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

For the direct measurement of high neutron flux densities (>10^9 n/cm^{2}sec) by radiation-induced dc current, polycrystalline semiconductor material can be used. If the electrical parameters are chosen in such a way that the sensitivity of the detector is at the minimum needed for the measurement, an improvement in radiation resistance of approximately a factor of 100 may be gained in comparison to single-crystal surface-barrier detectors. (R.W.R.)

57747 SEMICONDUCTOR GM COUNTER. Keil, G.; Ruge, I. (Institut fuer Technische Elektronik, Munich). pp 284-301 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

At a detector bias greater than the breakdown voltage, the discharge in a p—n junction is limited only by the positive internal resistance of the diode. If the breakdown area is small, the breakdown current flows in the form of current pulses of constant amplitude that are triggered by single minority carriers and that are quenched by a statistical process. In this mode the diode behaves like a Geiger—Mueller counter. The development of such a detector and its characteristics are described, and circuits for stabilization of the operating point and possible applications are given. (R.W.R.)

57748 GAMMA ENERGY RESOLUTION OF MULTIPLYING DETECTORS. Berg, G.; Heuberger, A. (Institut fuer Technische Elektronik, Munich). pp 319-30 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

Just as the ionization chamber and G—M counter have semiconductor analogs in the Ge(Li) detector and breakdown counter, the multiplying detector is analogous to the gas proportional counter. The principle on which the multiplying γ-detector works is briefly described, and then the various contributions to the noise of the detector are considered in some detail. (R.W.R.)

57749 CHARGED PARTICLE DETECTORS MADE BY IMPLANTATION. Garin, A. (CEN, Saclay, France); Oria, M.; Waast, B. Radiat. Eff.; 10: No. 1-2, 43-8(Jul 1971).

The process of ion implantation was applied to the fabrication of both windowless charged-particle detectors and position-sensitive detectors; the ions used were lithium, boron, and phosphorus. The beams of boron and phosphorus ions were produced by a classical isotope separator, the lithium ion beam by an apparatus built in the laboratory. The optimum operating conditions were chosen by measurements of the implantation profiles of several diodes produced under different conditions. The results of tests for PN and PIN charged-particle detectors are presented. (auth)

57750 PERFORMANCE OF FOIL SUPPORTED ELECTRODE SYSTEM AND PLANS FOR IMPROVEMENT. Neumann, M. J. (Univ. of Chicago). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 84-5(Apr 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The use of foil-supported wires for counter arrays is considered. Previous problems are ameliorated by using a good insulator for supporting the foil and eliminating the field distortion caused by surface charges through a self-shielding geometry. (R.W.R.)

57751 LOW-NOISE, WIDE-BAND, CURRENT-PULSE PREAMPLIFIERS FOR NEUTRON COUNTERS. De Lorenzo, J. T. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 114-16(Apr 1971).

An improved, low-noise, wide-band current preamplifier was developed for use with a fission counter having a 100-nsec electron collection time. The signal-to-noise ratio of the preamplifier and its insensitivity to component parameter variations and temperature changes exceed that of any commercially available unit. A differential version was developed to exploit the balanced configuration of the counter. A 20% improvement in signal-to-noise ratio was obtained with good common-mode rejection from 50 kHz to 30 MHz. (auth)

57752 STUDY ON DETECTION METHODS OF ^{14}C-LABELLED COMPOUNDS. Isoi, Koichiro; Ishida, Kazuko; Ikeda, Yoko (Mukogawa Women's Univ., Nishinomiya, Japan). Mukogawa Joshi Daigaku Kiyo, Shizenkagakuhen; No. 17, 357-9(Aug 1970). (In Japanese).

When biosynthesis path of C_6-C_3 type compounds was investigated with [^{14}C−(U)]-phenylalanine as a tracer, chromatoscanners, autoradiography and liquid scintillation counters were used to detect radioactive substances. These three methods for the detection of ^{14}C-labelled compounds were compared with one another. The detection limit of the autoradiography was lowest. Chromatoscanner and liquid scintillation counter methods had the lower detection limits of the same order. As an application, a purity test of commercial [^{14}C−(U)]-phenylalanine was performed. It was found that for quantitative tests, the liquid scintillation counter method was most effective, and for qualitative tests, autoradiography was most suitable. (Japan)

57753 ESTIMATION OF COEFFICIENT OF LUMINESCENCE IN ORGANIC SCINTILLATOR BY USING DIGITAL COMPUTER. Nishikawa, Kiyoshi (Konan Univ., Kobe, Japan); Ishiketa, Tadashi. Mem. Konan Univ., Sci. Ser.; No. 13, 1-21(Nov 1970).

In determining energy spectra of gamma rays using organic scintillators with electronic digital computers, relations between the range or energy loss of recoil electrons in the scintillators through Compton scattering processes and the pulse height in the output of photomultiplier tubes must be numerically obtained. If gamma rays of energy E make stochastically the recoil electrons having kinetic energy T through Compton scattering, and the electrons have the range R in the organic scintillators or have the energy loss ϵ along the range R, probability functions of K_1 (R,E) or K_1 (ϵ,E) of the above process were estimated by Monte Carlo simulation, while the pulse height (V) distribution was represented as a function g(V). These results are shown. The obtained relationship is expressed as coefficients $a = \Delta V/\Delta R$ or $\alpha = \Delta V/\Delta\epsilon$. These are coefficients for the efficiency of luminescence. (Japan)

57754 MULTICRYSTAL TOMOGRAPHIC SCANNER FOR MAPPING THIN CROSS SECTION OF RADIOACTIVITY IN AN ORGAN OF THE HUMAN BODY. Brill, Aaron B.; Patton, James A.; Erickson, Jon J.; King, Paul H. (to United States Atomic Energy Commission). U. S. Patent 3,591,806. 6 Jul 1971. Filed 17 Mar 1970.

A multicrystal tomographic scanner is utilized for mapping thin slices or cross sections of radioactivity in an organ of the human body which has been injected or ingested with a suitable radioisotope. A plurality of radiation detectors are arranged in a cylindrical monoplanar array with each detector focused in such a manner that the fields of view of all of the detectors intersect at a common point, and the detectors are driven mechanically such that this common point of the detectors is caused to move in a rectilinear raster of about 8 inches square. The distribution of radioactivity measured by the detectors due to the amount of radioisotope within the area being scanned is stored in a computer memory and reproduced on an oscilloscope display, as the section is being examined. (auth)

57755 RADIATION DETECTOR: SOLID STATE RADIATION DETECTION USING AN INSULATOR BETWEEN THE EMITTER AND COLLECTOR. Warren, Holland D. (to Babcock and Wilcox Co.). U. S. Patent 3,603,793. 7 Sep 1971. Filed 1 Aug 1969.

An improved self-powered detector which affords a prompt response to changes in the neutron and gamma flux incident upon a ytterbium emitter by using a thickness of insulator between the emitter and collector that is sufficient to absorb delayed electrons emitted at a lower energy level from the emitter and yet allow prompt electrons emitted at a higher energy level from the emitter to reach the collector is described. By thus eliminating the delayed electrons, the signal output current of the detector represents the instantaneous value of the incident neutron and/or gamma flux. (auth)

57756 RADIATION DETECTOR WITH GAS-PERMEABLE RADIATION WINDOW. Kimmel, Hermann. U. S. Patent 3,603,831. 7 Sep 1971. Priority date 13 Sep 1967, Germany.

A detector for ionizing radiation of relatively low energy of the

XUM

type in which a normally nonionized gas in a chamber connects two high-voltage electrodes and is ionized by radiation entering the chamber through a window in the chamber wall relatively permeable to the radiation, provided with a window of fine wire gauze and continuously supplied with gas under a pressure sufficient to prevent entry of contaminants from the environment through the openings in the gauze, is described. The screen window is more permeable to low-energy radiation than known windows. (auth)

57757 SEGMENTED GAMMA RAY DETECTOR AMPLIFIER SPECTROMETER. **Chase, Robert L.** (to United States Atomic Energy Commission). U. S. Patent 3,603,796. 7 Sep 1971. Filed 23 Jan 1969.

An amplifier for use with a segmented-gamma ray detector employing internal detector summing of the linear signal to eliminate the need for complicated external preamplifier gain adjustment and stability is described. Each segment of the detector is capacitively coupled to a voltage sensitive preamplifier and a charge preamplifier takes the whole charge of the detector. (auth)

57758 METHOD AND APPARATUS FOR MEASURING FAST NEUTRON FLUENCES WITH CADMIUM SULFIDE OR CADMIUM SELENIDE. **Johnson, Ralph T. Jr.** (to United States Atomic Energy Commission). U. S. Patent 3,588,505. 28 Jun 1971. Filed 30 Jun 1969.

An apparatus and method for measuring neutron fluences including a body of material having elements therein which are transmuted by neutrons into radioisotopes which decay by emission of radiation and produce ionization in the body of an amount relatable to the intensity of the neutron fluence are described. The neutron fluence is calculated by measuring the original electric conductivity of the body, exposing it to the neutron fluence, measuring the change in conductivity of the body due to the ionization from the decay of the radioisotopes transmuted by the neutrons, and computing the fluence, taking into account the time of decay of the radioisotopes; or, alterntatively, after exposure to the neutron fluence detecting each ionization event, determining the event rate, and computing the fluence, taking into account the time of decay of the radioisotopes. (auth)

57759 PHOTON DETECTOR UTILIZING A WELL-TYPE SCINTILLATION CRYSTAL. **Mays, Charles W.; Lloyd, Ray D.; Atherton, David R.** (to United States Atomic Energy Commission). U. S. Patent 3,591,807. 6 Jul 1971. Filed 6 Sep 1966.

A novel photon detector is described. The preferred embodiment comprises a scintillating crystal having a uniquely oriented counting chamber disposed transversely within the scintillating crystal, and the crystal has a plurality of planar faces uniformly spaced from the counting chamber to accommodate a plurality of photomultiplier tubes. The novel photon detector has the capability of achieving a uniform counting rate independent of sample position or sample volume and shape. (auth)

57760 RADIATION DETECTOR FOR INSERTION INTO A BLOOD VESSEL. **Kobayashi, Tetsuji; Seiichi, Takayanagi** (to Tokyo Shibaura Electric Co., Ltd.). U. S. Patent 3,598,109. 10 Aug 1971. Filed 11 Sep 1967.

A radiation detector for medical use to be inserted into the blood vessel is provided with a blood channel disposed in parallel with the blood flow. A semiconductor element is placed in the blood channel to detect the radiations from the radioisotope introduced into the blood vessel, with the radiation-receiving face thereof exposed to the interior of the blood channel. (auth)

57761 POWER METER FOR MEASUREMENT OF RADIATION. **Mefferd, Wayne S.; Rorden, Robert J.; Hobart, James L.** (to Coherent Radiation Labs., Inc.). U. S. Patent 3,596,514. 3 Aug 1971. Filed 2 Jan 1968.

A power meter for measuring radiation including a radiation target disc, a heat sink for cooling the periphery of the disc, and a circumferentially extending array of radial thermocouples for measuring the total power of energy incident of the central area of the disc as a function of the sum of radial temperature gradients of the disc is described. (auth)

57762 CHARACTERISTICS OF HIGH PURITY GERMANIUM AND SILICON RADIATION DETECTORS. **Drummond, William Eric.** Stanford, Calif.; Stanford Univ. (1971). 63p. University Microfilms Order No. 71-19,675.

Thesis.

Characteristics of silicon and germanium radiation detectors are developed from an analysis of the energy-loss mechanisms for hot carriers. A calculation of the probability of ionization versus primary electron energy in silicon indicates an effective ionization threshold several times the bandgap energy. Calculations give an average energy expended per created pair (ϵ) of 4.24 eV. Closer agreement with the experimental value of 3.67 eV is achieved by lowering the phonon to ionization scattering rate ratio. Temperature effects, which enter through changes in the bandgap, are calculated to be $\partial\epsilon/\partial E_g = 1.73$. The analysis also predicts a Fano factor for silicon of 0.059. Discussion of the germanium situation is based on the premise of hot-carrier behavior similar to that in silicon. Because germanium has a more complicated bandstructure, two sets of calculations are made using different effective bandgaps. With $\epsilon = 2.96$ eV at 90°K, very similar results are obtained in both cases and indicate $\partial\epsilon/\partial E_g \approx 1.77$ and $F \approx 0.066$. The fabrication and characterization of high-purity germanium radiation detectors is also described. These detectors are n–i–p diodes with a shallow (1.5-μ) diffused junction and a noninjecting metal–semiconductor contact. Electrical measurements show that with 500 volts of bias these detectors are fully depleted and have a capacitance of approximately 4.5 pF. Detection characteristics are determined from measurements of γ rays and x rays over the energy range of 6 keV to 136 keV. A deviation from linearity of less than ±0.2 percent was measured. The resolution of the detectors is characterized by an effective Fano factor of 0.12. The average energy expended per created pair was determined to be 2.95 ± 0.02 eV at 90°K. (TSS)

57763 DOUBLE-DETECTOR SCINTICAMERA FOR VISUALIZATION OF COLD NODULES IN BULKY ORGANS. A PRELIMINARY PHANTOM INVESTIGATION. **Mikolajkow, A.; Jasinski, W. K.** (Inst. of Oncology, Warsaw). Nucl.-Med.; 10: No. 2, 201-3(15 Jul 1971).

An investigation of a liver-slice phantom embedded in a thick Perspex block was carried out to determine the performance of a double-detector scinticamera. Results indicate that when a scintigraphic examination is aimed at the detection of cold nodules situated in unknown positions in bulky radioactive organs, the performance of a two-detector camera may be better than that of a conventional instrument. (W.H.K.)

57764 LIEGE ANTHROPOGAMMAMETER AND ITS CLINICAL USE. **Heusghem, C.; Delwaide, P. A.** (Univ., Liege). Bull. Acad. Roy. Med. Belg.; 9: 439-95(1969). (In French).

The Liège whole-body counter consists of a plastifluor detector of approximately 4 π geometry, 18 photomultipliers and a 3-channel spectrometer. Its principal characteristics are described including resolution, which is relatively low, and efficiency, which exceeds 50%. Efficiency is constant throughout a wide range of activities. For measurements of body ^{40}K and ^{137}Cs, interference due to the low discrimination requires the use of an indirect method of calibration based on algebraic manipulation of the values obtained. Under these conditions, a counting time of 200 seconds yields body potassium values that are precise and reproducible to within 5%. Initial values obtained by measurements in normal subjects are in agreement with findings reported in the literature; pathological variations can thus be compared with reliable indices according to age and weight. Patients with cirrhosis of the liver, diabetes and essential hypertension show lower potassium body content than the predicted normal values, when analyzed statistically. The body counter also is useful for radioactive contamination controls; particularly the ^{137}Cs body burden is in all cases measured. Examples of metabolic studies with one or two tracers in the fields of pharmacology and toxicology are also reported. (auth)

57765 NONLINEAR RESPONSES OF POLY(VINYL TOLUENE) PLASTIC SCINTILLATORS AT HIGH EXCITATION DOSES. **Powell, R. C.; Harrah, L. A.** (Sandia Labs., Albuquerque, N. Mex.). J. Chem. Phys.; 55: No. 4, 1878-84(15 Aug 1971).

The light output intensities from commercial Pilot B and similar plastic scintillators having a poly (vinyl toluene) host were measured as a function of dose from a pulsed electron beam machine. At doses exceeding $\sim 1.5 \times 10^4$ rad in 3×10^{-9} sec, nonlinear responses were observed. For pure poly (vinyl toluene) the nonlinear responses can be explained by bimolecular interaction of the host excited states, and the product of the excited-state yield times the interaction rate constant is 8.5×10^{-10} cm^3 sec^{-1} per 100 eV. For Pilot B it is concluded that the dominant quenching mechanism is the reabsorption of scintillator light by mononegative ions of the center fluor, p-terphenyl. This conclusion is corroborated by the observation of the spectrum of decreased light transmission through the sample after electron excitation at high doses. The observed product of ion yield times extinction coefficient is 2.3×10^5 liter mole^{-1} · cm^{-1} per 100 eV. (auth)

57766 X-RAY SENSITIVITY OF SEMICONDUCTOR RADIATION DETECTORS. **Gorenburg, L. S.; Pogrebnoi, Yu. P.** Defektoskopiya; No. 2, 98-107(1971). (In Russian).

The application of semiconductor radiation detectors to ionization defectoscopes is described. The x-ray sensitivity of various types of semiconductor detectors was investigated, and the dependence of the sensitivity on their class was established. The relaxation characteristics of semiconductor detector operation with alternating current at 50 Hz was studied as affected by x-radiation. Recommendations are offered concerning the feasibility of using semiconductor detector types of defectoscopes and automated devices in radiation fields. (tr-auth)

57767 RECENT ADVANCES IN RADIATION PROTECTION MEASUREMENT TECHNIQUES. Brunner, H. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen,Switzerland). pp 181-204 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

A review is given of recent developments of techniques and detectors in the fields of external counting of incorporated radionuclides, detectors suitable for neutron dosimetry under normal and accident conditions, assessment of inhalation exposures and other applications for individual dosimetry. The performances of available methods and detectors are compared to the requirements and experiences of applied health physics. (155 references) (auth)

57768 ABSOLUTE MEASUREMENT OF FLUENCE AND FLUX DENSITY OF LOW-ENERGY X- AND γ-FIELDS BY SEMICONDUCTOR DETECTORS. Gossrau, M.; Drexler, G. (Inst. fuer Strahlenschutz, Neuherberg, Ger.). pp 205-10 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The description of a radiation field by the spatial distribution of the energy flux density or the fluence has been used in standard dosimetry for a long time as these physical quantities could be determined from calorimetric measurements. For low-energy X-rays total absorbing ionization chambers and silicon surface-barrier counters have been employed to measure energy fluence by the charge released in the detector. The use of a germanium pin diode detector is investigated. The main advantages are the simple experimental arrangement and the fact that, even at very low dose rates, the detector current can easily be measured with great accuracy. The effects of recombination and trapping of charge carriers as sources of systematic errors are discussed. The effect of incomplete absorption of γ-radiation has been taken into account by a Monte Carlo calculation. The lower limit of the measurement range can be estimated to be 20 $\text{erg} \cdot \text{cm}^{-2} \cdot \text{sec}^{-1}$. To compare the method with other techniques mentioned, a set of five X-ray qualities were used to obtain the photon spectra. It can be shown that the energy of 2.98 ± 0.01 eV needed to produce an electron-hole pair in germanium provides the possibility of determining the fluence of an X- or γ-field in the energy range under consideration to an accuracy of ±3.0%. (auth)

57769 PLANAR DISTRIBUTION OF LOW-ENERGY β-NUCLIDES USING COMPUTER CONTROLLED EQUIPMENT WITH A SEMICONDUCTOR DETECTOR, AND COMPARISONS WITH OTHER METHODS. Tykva, R. (Inst. of Organic Chemistry and Biochemistry, Prague). pp 211-24 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

A procedure and apparatus used to determine the relative planar distribution of low-energy beta nuclides (e.g. ^{3}H, ^{14}C) or of certain other radionuclides (e.g. ^{32}P, ^{57}Co) is described. The method permits the determination of both individual radionuclides and larger numbers of radionuclides present in a sample. A specific radionuclide can be determined at various parts of the sample using the preset program with various accuracies and with various planar resolving powers. The maximum sample height is 5 mm, and the planar dimensions may be approximately 82 mm × 88 mm. The computer-controlled detection system uses a partially-depleted surface barrier silicon detector placed in the evacuated space above a table that constitutes the sample support and that can be moved in the plane of the table. The minimum scanned area is 1 mm × 1 mm. The fully-automated evaluation of individual scanned sites is effected numerically in terms of measured counts per time interval, chosen arbitrarily and displayed graphically with different levels indicated by distinguishing colors. The contours of the sample can also be displayed. One single detector determines the contours of the sample, for thicknesses between 0.02 mm and 2.9 mm. The method can be also used for the radioactivity determination of individual discrete samples (e.g. in dry residues of samples) or for detection on paper strips. The application of the method for histologic sections of mouse embryos and for gel electrophoresis is described. The results obtained by the method described are compared with the results obtained either by autoradiography of identical planar preparations or using a liquid scintillation spectrometer after isolation of samples from the individual scanned sites of the planar preparations. The basic parameters of semiconductor detection are also compared with the results of measurements using a Geiger-Müller counter with a thin window, a 2 π windowless flow counter, and an internal proportional gas counter. (auth)

57770 IN VIVO MEASUREMENT OF PLUTONIUM AND OTHER VERY LOW ENERGY EMITTERS. Huth, G. C.; Moldofsky, P. J. (General Electric Co., Philadelphia). pp 225-34 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

A new type of radiation detector, the silicon avalanche diode, has made possible the previously impossible in vivo measurement of beta radiation as low as 5 keV and X-ray and gamma radiation as low as 1 keV. The solid state analogue of the proportional counter, the avalanche diode, provides internal charge gain within the silicon wafer, raising the radiation-induced signal far above the detector noise level. By this mechanism, radiation formerly below detector noise level can be detected with extremely low background (on the order of 1 count per minute) at temperatures up to 100°C. Applications are being explored in nuclear medicine in the fields of bone scanning with ^{125}I, eye tumor studies with ^{32}P and ^{125}I, rapid analysis of skin cancer response to treatment (^{32}P) and in vivo detection of plutonium via the 13.6, 17.4, 20.5 keV L X-rays from the uranium daughter. All these applications make use of the three principal characteristics of the avalanche detector: internal gain; small size—as small as 3 mm (or as large as 30 mm) diameter; and low noise and high sensitivity even at elevated temperatures. Currently, in vivo measurements of plutonium lodged in bronchial and metastinal lymph nodes behind the lungs are proceeding using a flexible detector probe that is inserted in the oesophagus, in effect, partially swallowed. The experiments are performed with dogs whose inhaled plutonium has been filtered by these nodes from the lungs. At present, a minimum detectable amount at an 84% confidence level of ^{239}Pu of typical composition (i.e., including small amounts of other isotopes) detected by an avalanche detector in the oesophagus is about 20 nCi. The results of the nuclear medical investigations being carried out by a dozen physicians throughout the United States on these and other applications indicate that the avalanche detector is making possible, in many cases for the first time, reliable in vivo measurement of extremely soft radiation with drastically reduced background and over a wide temperature range. (auth)

57771 SOFT X-RAY SPECTROMETRY WITH SEMICONDUCTORS OPERATING IN A CASCADE REGIME. Peyre-Lavigne, A. (Universite Paul Sabatier, Toulouse); Peyre-Lavigne, Monique; Blanc, D.; (and others). pp 241-52 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The detection of soft X-rays is an important problem in radiological protection, especially in the matter of external counting. With a view to such applications, silicon detectors were constructed operating in the cascade régimes. Having calculated the internal multiplication factor and the background noise of such a detector, the types of structure that could be used for designing spectrometers of good quality were determined. These are, in order of merit, diodes (n type or p type metal semiconductors) and P + N and N + P diffusion junctions. The threshold voltage of the cascade is obtained by measuring the characteristics (inverse-current, voltage) and the corresponding capacitance. Measurements of noise level as a function of polarization voltage were combined with those of the multiplication factor and of current intensity due to microplasmas. The presence of microplasmas was found to be closely linked with the technology of detector design. The spectrometric characteristics of the detector, obtained by irradiation with alpha particles from a ^{241}Am source, are given. (auth)

57772 ASSAY EFFICIENCY AND RESPONSE FOR CYLINDRICAL SCINTILLATION CRYSTALS AND LARGE-AREA GAS COUNTERS APPLIED TO WHOLE-BODY COUNTING. Morsy, Samira M.; Abu-Bakr, M. Y.; Aloush, A. A.; Youssef, S. K. (Atomic Energy Establishment, Cairo). pp 253-67 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological

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radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

A new method for evaluating the efficiency of assay for some conventional whole-body counting arrangements is given. The evaluation is based on a generalized formula for calculating the total absolute detection efficiency in the case of a cylindrical scintillation crystal and a large-area gas counter for ^{239}Pu detection. For the cylindrical scintillation crystal, the effect of body thickness on the response and assay efficiency was taken into account by considering the human body to be represented by an elliptical cylinder of finite length equal to that of a standard man. The attenuation length inside the phantom was calculated by solving simultaneously the equation representing the direction of the emitted photon and that representing the surface of the phantom. For this case the relative values of the detection efficiency for a point source moving inside the phantom in chair geometry are given. In scan geometry, the effects of scan length on both the response and the efficiency are examined. In the case of the large-area gas counter, the effect of source position on the detection efficiency was examined. The absolute value of the detection efficiency has also been computed for different thicknesses of the counter. The main advantage of the present method is the realistic simulation of the counting arrangements, for which optimization studies can be performed, not only with respect to some given geometry, but also for the purpose of selecting the most appropriate geometry. The results reflect the accuracy inherent in the evaluated activity for the different geometrical arrangements. Such inherent accuracy has to be considered in the course of determining the corresponding radiation dose. (auth)

57773 DIRECT MEASUREMENT OF PULMONARY PLUTONIUM CONTAMINATION. Boulay, P. (CEA, Bruyeres-le-Chatel, France). pp 287-97 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

For the direct measurement of pulmonary plutonium contamination the following three conditions must all be met: the detector used must have a suitable window surface and efficiency; the background noise should be very low; and it must be possible to reduce the error due to morphology. The counter proposed has a useful diameter of 190 mm and a mean efficiency of 60% for ^{239}Pu X-rays. The background noise is reduced by lead shielding, 10 cm thick, covered with 1 mm of stainless steel, an anti-coincidence circuit and a pulse rise-time discriminator. Under these conditions the sensitivity threshold can be estimated at 5 nCi of ^{239}Pu for a standard man. A method of internal calibration of the individual based on additional ^{233}Pa overloading is proposed. (auth)

57774 MULTIPLE PROPORTIONAL GAS COUNTER FOR THE CARTOGRAPHY OF RADIOELEMENTS. Allemand, R.; Brey, C.; Gagelin, J. J.; Laval, M. (CEA, Grenoble, France). pp 327-34 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Work already done on the visualization of thermal neutron diagrams (neutron diffraction) has been applied to studies on the visualization of X-ray or gamma emitters using proportional (gas) counters. The use of induced electric charges permits each nuclear event detected in the gas to be associated with two electrical signals on two different electrodes. These electrodes are geometrically positioned and interconnected so as to form a matrix, each point of this matrix constituting a detection cell. For each event there is then a corresponding address (X, Y). Each line and each column comprises an electronic measurement path so that a coincidence logic (X, Y) permits addressing of the information in a storage and visualization element. The encouraging results obtained on an experimental chamber have enabled the development of a multicounter intended for use in the cartography of ^{125}I-labelled thyroid glands. The device developed also makes it possible to analyze simultaneously the diagrams of powders or monocrystals. This method, when adapted for external counting can determine precise location of body burdens of X, gamma, or beta emitters. (auth)

57775 MEASUREMENT OF FAST-NEUTRON SPECTRA WITH THRESHOLD DETECTORS. Kramer-Ageev, E. A.; Troshin, V. S.; Tikhonov, E. G.; Ushakov, S. N. (Inst. of Engineering Physics, Moscow). pp 365-71 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Threshold detectors are a useful tool for the study of fast-neutron spectra, which are necessary for solving many problems in radiation physics, including the determination of the tissue dose of neutrons in emergency situations. Several methods of calculating high fast-neutron fluxes have been developed including representation of the fast-neutron spectra in the form of a series expansion in terms of orthonormalized functions, the expansion coefficients being sought from the condition of minimum standard deviation; a series expansion of the spectrum in terms of a system of orthogonal functions consisting of threshold cross-sections; and an iteration method using the Bayes conditional probability theorem. However, all the above-mentioned methods are very sensitive to errors in the initial data. The proposed method is suitable for analyzing the spectra of comparatively low fast-neutron fluxes. It consists in calculating the integral neutron spectra from the measured activities and effective threshold cross-sections and representing the differential spectrum sought as an exponent in each interval selected (not less than 1 MeV in width). The latter interval includes the effective thresholds of at least two reactions. The spectrum values at the boundaries of the interval are determined successively from the higher to the lower energies with the help of the transcendental equations. The indeterminateness in the spectrum obtained by this method is 10%, when the initial data are correct to within approximately 5%. The method permits the use of iterative refinement for the spectra which differ considerably from the fission spectrum. (auth)

57776 NEUTRON DOSIMETRY WITH RADIATION ELEMENTS. Hosemann, R.; Haase, J.; Junker, D.; Melde, D. Fritz-Haber Institut, Berlin). pp 373-80 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The radiation element is a vacuum cell with two special electrodes that are charged when irradiated. The resulting potential difference is measured with a quartz-fibre electrometer. Radiation elements are self-powered, measure radiation doses independent of dose rate and have a practically unlimited storage time due to their extremely good insulation. Radiation elements become charged if the electrodes emit different numbers of electrons. This is achieved for X-rays and γ-rays by using electrodes made of materials of different atomic numbers. Slow neutrons are captured in an electrode made of silver or rhodium by a (n,γ) process producing short-lived β-active isotopes. For fast neutrons a moderator must be used. Fortunately the human body has the optimum dimensions required for this purpose. Dosimeters with radiation elements therefore cannot measure free air doses of neutrons, but careful investigations have proved that they are reliable indicators for neutron fields that are of interest in accident dosimetry. Dosimeters with silver electrodes of 0.9 cm o.d. yield a sensitivity of about 3.5 V/rad to thermal neutrons and 0.5 V/rad to epithermal neutrons, which correspond to full-scale readings of about 30 rad and 200 rad, respectively. Dosimeters with the same sensitivity to thermal and epithermal neutrons and γ-rays have full-scale readings of 500 rad. Doses between about 50 and 500 rad, which require immediate medical attention, can be read off directly, whereas the less dangerous doses, between 5 and 50 rad, are stored latently and can be read off later. (auth)

57777 PHYSICAL CHARACTERISTICS OF DIRECT-CHARGE DETECTORS. Ivanov, V. I.; Kulakov, G. V.; Makhaneva, G. I. (Inst. of Engineering Physics, Moscow). pp 381-90 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The results of studies on the physical characteristics of direct-charge detectors ("radiation elements") designed to measure gamma- and neutron radiations are presented. Data on the relationship between accumulated charge and the form, material and thickness of electrodes, and electrode spacing are discussed. The influence of space charge on the upper measurement limit is considered from a theoretical viewpoint. Detector sensitivities calculated on a computer are also given. Various aspects of the practical application of direct-charge detectors are discussed. (auth)

57778 IONIZATION CHAMBERS WITH A LIQUID DIELECTRIC. Ivanov, V. I.; Kleshchenko, E. D.; Frolov, V. V. (Inst. of Engineering Physics, Moscow). pp 391-7 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The mechanism of ionization current generation under the action of radiation is studied. Volt-ampere characteristics are analyzed and various aspects of the practical application of liquid ionization chambers to the measurement of ionizing radiations are discussed. (auth)

57779 MONITORING SYSTEM FOR THE ASSESSMENT OF REACTOR SHIELD PERFORMANCE. Lakey, J. R. A.; Martin, A. (Royal Naval Coll., Greenwich, Eng.). pp 445-52 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The objectives of a shield survey and the results of intercomparisons are presented, and recommendations on the selection of a monitoring system are given. The performance of a reactor shield must be assessed efficiently to enable immediate repairs to be made to defective shields. Correlation of survey results with shield designer's predictions has proved difficult and the factors contributing to the disagreement have been examined. The shield designer uses flux-to-dose conversion factors which neglect the radiation equilibrium situation at the shield-air interface and the effect of attenuation and scattering external to the shield. The presence of the operator can significantly influence a measurement. The use of the "maximum exposure dose" (MED) concept is recommended for gamma photon predictions and this is compared with absorbed dose measurements in phantoms. Shield survey instruments must have a flat response over a wide range of energies. For example, many gamma dosimeters are designed for use at energies up to about 2 MeV whereas around most reactors a proportion of dose is due to 6 MeV gamma photons, with some contribution from higher energies. Tests were carried out to select suitable detectors using actual reactor operating conditions and simulated conditions at specific energies, notably 6 MeV. In practice discrepancies exceeding a factor of 3 were frequently found. A comparison was made between thermoluminescent dosimeters and film badges for the purpose of fixed position integrating dosimeters. The film dosimeter (AERE/RPS) was found to over-estimate by a factor of 2 for 6 MeV gamma radiation and in practical situations over-estimated by 20 to 80%. Thermoluminescent dosimetry is recommended for shield surveys provided that a build-up cap is used to achieve charged particle equilibrium. (auth)

57780 DETECTION AND ALARM SYSTEM FOR ACCIDENTIAL NUCLEAR EXCURSIONS. Benezech, G.; Gey, A.; Guillot, P.; Prigent, R.; Renard, C. (Commissariat a l'Energie Atomique, Cadarache, France). pp 453-63 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Since 1964 the CEA has developed two criticality detectors and had them placed on the market: one is sensitive to gamma radiation and consists of a scintillator in combination with a photomultiplier; the other is sensitive to neutron radiation and consists of a junction diode located opposite a concentrated uranium target. The entry into operation in 1969 of the CRAC device, which employs full-scale simulation of accidents in the liquid phase, has shed light on the specific dynamics of accidents which require extensive modifications in the system as developed. A new generation of equipment has therefore been studied; this has benefited from the greatly increased knowledge of the characteristics of criticality accidents and the improvements made in electronic components during the last few years (miniaturization, performance, reliability, etc.). Experiments have been carried out on a combined detector which is sensitive to both neutron and gamma radiation; this is an alarm device which responds to a predetermined dose over a wide dynamic range (10^6), the sensitivity of which covers practically all types of accident which may occur in the liquid phase and give rise to a significant irradiation hazard to personnel. It consists of a scintillator, whose response curve is proportional to the neutron + gamma radiation dose, coupled to a photoelectric cell operating in conjunction with an electronic measurement device; the triggering dose is 25 mrad, its insensitivity to a continuous dose rate being 300 mrad/h. Apart from its effective dose response, the main advantages of this detector are its very small dimensions and its attractively low cost. The principle of detection is still based on a logical two-out-of-three recognition system. The original features of the information processing case are such that the device is not affected by the dynamics of the accidents, regardless of the variations in sensitivity between each detector and their position in relation to the source. The logical signal transmitted by the detector is only retained in the alarm circuit if the detector reading is still above its threshold. However, if the threshold is momentarily exceeded due to the passage of a random source or an industrial parasitic signal, the fact is reported but cannot give rise to false alarm signals. (auth)

57781 ENERGY RESPONSE OF SOME COMMERCIAL BETA/GAMMA AND NEUTRON SURVEY INSTRUMENTS. Thompson, I. M. G.; Lavender, A.; Shipton, R. G.; Goodwin, Jane (Berkeley Nuclear Labs., Eng.). pp 505-31 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The variation in instrument response with energy is given for 29 commercially available gamma survey instruments in the photon energy range from 29 keV to 6 MeV and for five neutron survey instruments over the energy range 0.05 eV to 19 MeV. Details are also given of the radiation sources and the standardization of the radiation fields used for the energy assessments. (auth)

57782 INTERCOMPARISON OF THE CHARACTERISTICS OF BETA/GAMMA AND NEUTRON SURVEY INSTRUMENTS. Larson, H. V. (Battelle-Northwest, Richland, Wash.); Kathren, R. L.; Thompson, I. M. G. pp 533-65 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

A knowledge of the radiological and electrical characteristics of instruments used for the estimation of radiation hazards to personnel is vital both in the selection of instruments to be used and in assessing the integrity associated with measurements made with them. An intercomparison of radiation tests and evaluation tests of electrical and environmental characteristics carried out at Berkeley Nuclear Laboratories, United Kingdom and Pacific Northwest Laboratory, USA, on two neutron rem counters and two beta/gamma survey instruments is described. This comparison has served as a useful check on the techniques used by both the laboratories and clearly demonstrates the difficulties associated with beta and neutron dose measurements. A recommended evaluation program for portable radiation survey instruments is outlined. (auth)

57783 17th NUCLEAR SCIENCE SYMPOSIUM AND 2nd NUCLEAR POWER SYSTEMS SYMPOSIUM, NEW YORK CITY, NOVEMBER 4-6, 1970. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 10504(Feb 1971). (CONF-701109).

Separate abstracts were prepared for 70 papers. (R.W.R.)

For abstracts of individual papers see: 57359, 57360, 57395, 57784–57792, 57812–57821, 57892–57899, 57907, 57908, 58063, 58064, 58079, 58956, 59664–59668, 59898, 59899, 60001–60003, 60041–60043, 60050–60053, 60089, 60090, 60133–60135, 60180–60187, 60208, 60236, 60239, and 60248.

57784 SELF-TRIGGERED WIRE CHAMBERS FOR RADIATION IMAGING PURPOSES. Kaufman, Leon (Univ. of California, San Francisco); Perez-Mendez, Victor; Sperinde, Johnie M. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 64-7(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Spark chambers with digitized readouts offer distinct advantages in spatial resolution and coverage over other gamma-ray imaging devices. These chambers usually require external logic signals for triggering; in this paper a method that provides self-triggering spark chambers is described. Initial tests of a 45-cm × 45-cm spark chamber with ^{60}Co and ^{198}Au samples are also described. (auth)

57785 WHOLE-BODY COUNTER FOR NEUTRON ACTIVATION ANALYSIS. Cohn, S. H.; Dombrowski, C. S. (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 73-8(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

For the measurement of total-body calcium, sodium, chlorine, nitrogen, and phosphorus by neutron activation analysis in vivo, there are two basic requirements. It is necessary to achieve a uniform neutron flux through the human subject. It is also necessary to measure the induced radionuclides in the body quantitatively. The Brookhaven 54-detector whole-body counter with its on-line computer satisfies this latter requirement by providing an absolute measure of the induced activity in the subject, independent of its location in the body and the size of the body itself. The application of this whole-body counter in the measurement of total-body calcium, sodium, chlorine, nitrogen, and phosphorus in vivo is described. (auth)

57786 FAST ELECTRONIC MODULES FOR NUCLEAR PHYSICS EXPERIMENTS. Horvath, Pavel; Ondris, Lubomir (Joint Inst. for Nuclear Research, Dubna, USSR). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 102-7 (Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Fast electronics modules for nuclear physics experiments are under design at Dubna. In this paper the following modules are described: a pulse shaper with a fixed discrimination level, a pulse shaper using the constant-fraction-of-pulse height technique, and a two-fold coincidence unit. The modules for discrimination and timing signals contain the fan-out standard circuit with both nanosecond logic and subnanosecond outputs. The compensation of temperature variations of the discrimination level and the compensation of time drift of subnanosecond output pulses is designed and introduced. In the pulse shapers after the temperature compensation was introduced, the long time stability and time drift of subnanosecond logic output pulses were measured and found to be within ±10 ps/24 hours. Attempts are made to build a coincidence–anticoincidence logic for nuclear physics experiments with the time resolution of 0.5 ns at FWHM. (auth)

57787 HIGH PURITY GERMANIUM FOR DETECTOR FABRICATION. Hall, R. N.; Soltys, T. J. (General Electric Research and Development Center, Schenectady, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 160-5(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The preparation of large (100)-oriented germanium crystals with net concentrations of electrically active impurities in the range 1 to 10×10^{10} cm^{-3} is described. This material has been used successfully for the fabrication of semiconductor detectors having depletion layers up to 8 mm thick, without using lithium compensation. Electrical evaluation is performed by studying the Hall coefficient as a function of temperature, and by measuring the resistivity along the length at 77°K. Dislocation densities in most crystals range from 2000 to 5000 cm^{-2}. Several dislocation-free crystals were also grown. The oxygen concentration, measured by lithium precipitation, is approximately 10^{14} cm^{-3} in germanium grown from quartz crucibles and much less than this when grown from graphite. The solubility of lithium in pure, oxygen-free germanium is found to be 3.5×10^{13} cm^{-3} at 23°C. (auth)

57788 AVERAGE ENERGY EXPENDED PER IONIZED ELECTRON-HOLE PAIR FOR α PARTICLES IN Si(Li). Key, J. R.; Rabson, T. A. (Rice Univ., Houston, Tex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 184-6 (Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

New results are obtained for the temperature dependence of ϵ, the average energy required to create an electron–hole pair by ionizing radiation, for α particles incident on lithium-drifted silicon surface-barrier detectors. For temperatures between 31 and 291°K, the application of fields up to 10^4 V/cm resulted in a saturated pulse height; this saturation eliminated the necessity for extrapolation procedures to determine ϵ. Between 4.2 and 31°K pulse height saturation was not observed. Below 31°K the presence of both fast- and slow-risetime components in the detector pulse prevented an accurate determination of the pulse height. A significant difference between the present results and those previously reported is that ϵ plotted vs the energy gap gives a linear curve over the entire range reported (31 to 291°K). (auth)

57789 METHOD OF CALIBRATION OF MOXON–RAE DETECTORS. Ellis, A. N.; Brown, W. K.; Farrell, J. A.; Fullwood, R. R. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 205-7(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A method of calibration of the Moxon–Rae-type gamma-ray detectors used in neutron-capture cross-section measurements with underground nuclear explosions is described. The method consists of measuring the activation and detector signal in individual resonances in samples of ^{197}Au and ^{238}U exposed to a neutron beam from an underground nuclear explosion. The resonances are resolved by time of flight. Since both the activation and the corresponding detector signal are known, the efficiency can be determined without measuring the incident neutron flux or sample capture cross section. (auth)

57790 INSTRUMENT FOR THE MEASUREMENT OF AURORAL ELECTRONS AND PROTONS. Lawrence, Dennis O.; Harrington, Timothy M.; Lawrence, James L. Jr.; Josias, Conrad S. (Analog Tech. Corp., Pasadena, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 237-48(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

An instrument to measure the energy spectrum of auroral electrons and protons was developed and is operational in orbit aboard ATS-5. It uses cylindrical coordinate electrostatic analyzers for detection of electrons and protons in the range of 50 eV to 50 keV. The analyzers focus these particles onto channel electron multipliers, which are followed by special-purpose amplifier–discriminator electronics. These electronics protect against counting losses due to gain degradation attributable to fatigue and to recovery effects associated with high counting rates. The pulse amplifiers have a dynamic range of 1000 : 1 and resolve 1-μs pulse pairs. Their fixed dead time (t_d) permits accurate correction to be made for counting rates exceeding $1/t_d$. A fast, ultrastable, programmable high-voltage scan system provides differential voltages between 0 and 6400 V in 62 exponential steps to the analyzer plates for energy selection. A digital servo permits either continuous sequential scanning over the 1000 : 1 range in energy, or automatic tracking of a spectral peak. Digital compression techniques are used to provide maximum data transfer to the spacecraft telemetry. (auth)

57791 PERFORMANCE OF LARGE GERMANIUM DETECTORS AT ELEVATED TEMPERATURES FOR SATELLITE APPLICATIONS. Nakano, G. H.; Imhof, W. L. (Lockheed Palo Alto Research Lab., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 258-63(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A measurement program was undertaken to investigate design criteria for satellite-borne Ge(Li) detector systems. The resolution, pulse height, reverse current, and efficiency were measured as a function of temperature and bias voltage for large Ge(Li) detectors. For space applications the important parameters are the knees (rapid changes) in the resolution and leakage current versus temperature. These features are observed to vary appreciably from detector to detector. (auth)

57792 LABORATORY QUALITY CHARGE SENSITIVE AMPLIFIER SUITABLE FOR SPACE APPLICATIONS. Alexander, R. M. (TRW Systems, Redondo Beach, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 264-74 (Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The amplifier described is designed for use with uncooled silicon nuclear-particle detectors commonly used in space instruments. The charge-sensitive preamplifier and two-stage shaping amplifier provides the performance of a laboratory quality instrument while simultaneously satisfying the stringent requirements imposed upon flight hardware. Double-differentiation–double-integration (DDDI) pulse shaping with pole-zero cancellation of the preamplifier decay time constant was selected on the basis of simplicity, adequate noise performance, and stability at high count rates. The components used in the design are compatible with hybrid microcircuit fabrication. Noise performance at 1 μsec DDDI time constants was measured to be 1.8 keV + 47 eV/pf FWHM (Silicon) for an amplifier consuming 100 mW. The operating temperature range is approximately −40° to +80°C. Further results of an extensive testing program are reported. (auth)

57793 RECENT TOPICS ON SEMICONDUCTOR RADIATION DETECTORS. Sakai, E. (Japan Atomic Energy Research Inst., Tokai). Genshiryoku Kogyo; 17: No. 6, 44-8(Jun 1971). (In Japanese).

A few topics on semiconductor radiation detectors are discussed. Low noise pre-amplifiers are being actively developed in order to realize very high ultimate energy resolution of Si and Ge detectors, and efforts are being made to manufacture large volume Ge(Li) detectors to obtain high gamma detection efficiency. Ge(Li) detectors manufactured by Li drift method are inconvenient because it must be continuously kept at liquid nitrogen temperature. If extremely pure germanium single crystals are obtained, p-n junction detectors might be manufactured by making n$^+$ and p$^+$ layers. Especially if the n$^+$ layer is made by implanting an n type impurity other than Li by the ion implantation method, the detectors may be usable, holding them at the liquid nitrogen temperature only during measurement. Also, GaAs and CdTe detectors are being investigated. They have possibilities of being operated as high resolution detectors at room temperature. The CdTe detectors also have the potential for neutron detection. (Japan)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 57362, 57886, and 60156.

57794 (INS-TCH-5) ABSOLUTE MEASUREMENT OF ALPHA RAY BY A SURFACE-BARRIER TYPE SILICON DETECTOR. Komura, Kazuhisa (Tokyo Univ. (Japan). Inst. for Nuclear Study). 14 Mar 1971. 16p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Performance tests of a surface-barrier type silicon detector purchased from ORTEC for α ray spectroscopy are described. ^{210}Po, ^{228}Th including daughter nuclides, natural uranium and ^{233}U fixed or electrodeposited on a stainless steel plate were used as α sources for measurement. ^{228}Th reached radioactive equilibrium in one month, and is useful as the source for measurement of energy resolution. Half-value width for α rays of 5.68 MeV from ^{224}Ra and 6.29 MeV from ^{220}Rn was approximately 65 keV as a result. The effective radii of the detectors were experimentally determined to be 18.0 ± 0.1 mm, and the overall accuracy for absolute measurement is approximately 1%. Also, the geometrical factors are studied. (Japan)

57795 (LB/G-3075) CONSTRUCTION OF RESPONSE MATRICES IN γ-SCINTILLATION SPECTROMETRY. Brust, R.; Richter, D. Translated by N. J. Davren (Atomic Energy Research Establishment, Harwell, Eng.), from Nucl. Instrum. Methods; 81: 132-40(1970). 23p. Dep. NTIS (U. S. Sales Only).

Handwritten MS. copy.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 29559. (R.W.R.)

57796 (ORNL-TM-3457) NEUTRON-CAPTURE-GAMMA RAY SPECTRUM CALCULATIONS FOR MATERIALS FOR POSSIBLE USE IN A ^{252}Cf NEUTRON ACTIVATION FACILITY. DeCarlo, V. A.; Arnold, E. D. (Oak Ridge National Lab., Tenn.). Jul 1971. Contract W-7405-eng-26. 31p. Dep. NTIS.

By using the ANISN computer program, neutron-capture-gamma-ray information was obtained for a number of materials, in a fixed arrangement, for use in a ^{252}Cf neutron activation facility. This information will be useful in the selection of materials to minimize gamma spectral interference. It was determined that a system using a source encapsulated in platinum encased in Zircaloy-2, with bismuth as the primary gamma shielding material, produced the lowest number of capture gamma rays and the highest thermal flux. (auth)

57797 CHANNELS ON SURFACES OF Ge(Li)-DIODES AND THEIR INFLUENCE ON X-RAY AND ELECTRON SPECTRA. Baldinger, E.; Haller, E. (Univ., Basel). pp 9-22 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

The effects of a channel on the surface of a small Ge(Li) planar detector on the detector properties were investigated. The detector capacitance and the length of the channel were measured. The presence of a surface channel produces a deformation of the electric field resulting in a degradation of the charge collecting efficiency in some parts of the diode. If electrons are irradiated into the intrinsic zone of a Ge(Li) diode, a surface channel will produce a tailing to lower energies in the shape of the electron lines. In γ spectroscopy a surface channel will reduce the active volume of the counter, particularly at low energies; therefore, the full energy peak efficiency decreases toward lower energies. The observed effects appear to be due to adsorbed gases. (R.W.R.)

57798 INFLUENCE OF TRAPPING EFFECTS ON Ge(Li) DETECTOR PERFORMANCE. Henck, R.; Gutknecht, D.; Siffert, P. (CRN, Strasbourg). pp 23-34 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (May 1970). See CONF-700527.

The variation of the trapping cross section with the electric field is studied, and a relation between the charge collection efficiency and the intrinsic detector resolution is obtained. By using this relation, it is possible to predict the peak shape obtained with uniform γ-ray irradiation, if the lifetime (or the drift length) of the carriers is known. Furthermore, a correlation is found, in most cases, between the observed trapping effects and the electron lifetimes measured at low temperature on the starting p-type material by the pulse-decay method. (R.W.R.)

57799 RECENT DEVELOPMENTS OF WELL-TYPE DETECTORS WITH LESS THAN 5 MICRONS DEAD-LAYER. Forcinal, G.; Meuleman, J. (RTC La Radiotechnique-Compelec, Caen, France). pp 62-9 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

Work on well-type Ge(Li) spectrometers with thin windows (less than 5μ) is described. Fabrication and thickness measurement of the entrance windows is first discussed. This is followed by an explanation of the fabrication and mounting of the detectors and a presentation of results obtained. A peak-to-valley ratio of 5 in the range of 40 to 100 keV is reported. (R.W.R.)

57800 DETECTOR PROBE FOR ENCAPSULATED Ge(Li)'S DIRECTLY IMMERSED IN LIQUID NITROGEN. Meyer, H.; Heinz, W. (Central Bureau for Nuclear Measurements, Geel, Belg.). pp 101-6 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

A detector probe for γ spectrometry and tests with encapsulated lithium-compensated germanium detectors is described. Detectors are stacked onto a probe, and the arrangement can be immersed directly into liquid nitrogen stored in a standard dewar container. A quick and repetitive assembly is possible with very small probability for a degradation of performance. The probe contains the front end of a charge-sensitive preamplifier, the elements of which are embedded in a solid foam material with low thermal conductivity and a small diffusion coefficient for water vapor. The element temperature within the probe can be adjusted for minimum noise. (auth)

57801 HIGH-RESOLUTION 5000 μ SILICON SURFACE-BARRIER DETECTORS. Klema, E. D. (Tufts Univ., Medford, Mass.); Crawley, G. M.; Garvey, G. T.; Foster, C. C. pp 119-26 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

Tests on three 5000-μ Si surface-barrier detectors are described. The results show that 30-MeV protons can be measured with such detectors with an energy resolution of 0.1%. (R.W.R.)

57802 MEASUREMENT OF THE CAPACITANCE CHARACTERISTICS OF LITHIUM-DRIFTED PIN-DIODES MOUNTED TOGETHER WITH A COOLED FET STAGE. Kuehn, E. W.; Schroeder, A. N. F.; Rook, D. A. (Univ., Cologne). pp 127-36 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

Measurement of the capacitance of Ge(Li) and Si(Li) detectors is discussed. Circuits suitable for making the measurement and graphs of capacitance as a function of detector bias are given. The appearance of surface channels on the detectors is noted. (R.W.R.)

57803 BACKGROUND MEASUREMENT OF A Ge(Li) DETECTOR APPLICATION TO THE DETERMINATION OF THE ^{76}Ge $\beta\beta$ HALF LIFE. Fiorini, E. (Univ., Milan. INFN, Milan); Pullia, A.; Bertolini, G.; Cappellani, F.; Restelli, G. pp 144-52 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

The construction of a low-background Ge(Li) spectrometer, used for the measurement of ^{76}Ge double beta decay [Lett. Nuovo Cim., I; 3: 149(1970)], is described. A tentative interpretation of the various sources of background and their relative contribution is given. (R.W.R.)

57804 DETECTION OF HIGH ENERGY γ-QUANTA WITH A PAIR-SPECTROMETER. Hanle, H. (Johann Wolfgang Goethe-Univ., Frankfurt am Main). pp 153-66 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

The use of a pair spectrometer for the detection of high-energy gamma rays is described, and the resulting pulse-height distributions are discussed for several different modes of operation. They show that the use of a pair spectrometer can appreciably improve complex spectra. Transitions of lower intensities can be measured by suppressing the Compton background. The number of peaks is reduced to that of the double-escape peaks. Even the twofold-co-

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incidence mode gives a considerable simplification of the spectra. (R.W.R.)

57805 LARGE WELL-TYPE GeLi DETECTOR FOR ACTIVATION ANALYSIS. Adams, F. (Univ., Ghent). pp 167-73 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

The fabrication and testing of a 60-cm^3, well-type Ge(Li) detector are described. Detection efficiency is excellent, as compared with that for a 3″ × 3″ right cylindrical NaI(Tl) detector and a 20-cm^3 coaxial Ge(Li) detector. Full-energy peak-detection efficiency was essentially independent of the sample position from the bottom of the well to a position 20 mm higher; thus, inaccuracies due to sample-positioning errors are removed. Resolution was 6 keV (fwhm) at 1.332 MeV. A serious drawback is the absorption of low-energy photons by the Ge dead layer. (R.W.R.)

57806 DESIGN AND LIMITATIONS OF A HIGH COUNT RATE TWO PARAMETER SYSTEM WITH A Ge(Li)-DETECTOR. Winter, J. (Central Bureau for Nuclear Measurements, Geel, Belg.). pp 188-2011 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

A two-parameter system used for the measurement of γ-ray spectra of neutron capture resonances is described. The total channel capacity of that system is roughly one million (4096 amplitude channels and 256 time channels for the neutron energy). Special features are rapid recovery after the gamma-flash of the linear accelerator, which overloads the system up to 10^4 times, and the ability to accept very high counting rates without losing events due to pile-up. The principle adopted to meet these requirements is as follows: The pulses from the overload-proof preamplifier are compressed to narrow pulses. Thus, the probability for pile-up is greatly reduced. A linear gate and a condition control unit select the useful events. Afterwards, these pulses are shaped as usual and analyzed in the ADC. As this preselection is made in the fast-pulse domain, high counting rate and overload problems are greatly reduced without losing useful events. Advantages, criteria for optimum design, and limits of this system are discussed in detail. (auth)

57807 EXPERIMENTAL INVESTIGATIONS OF EXOTIC SEMICONDUCTORS FOR NUCLEAR PARTICLE DETECTION. Willig, W. R.; Roth, S. (Siemen AG, Erlanger, Ger.). pp 202-15 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

A report is given on experimental investigations of InSb and PbO nuclear particle detectors. Results on energy resolution and depth of depletion layer are presented for InSb detectors at 78°K. High-temperature application of PbO detectors is discussed. Charge collection in PbO is studied from the detector response to alpha particles. (auth)

57808 SMALL ROD-SHAPED SILICON DETECTORS FOR MEDICAL APPLICATIONS. Glasow, P.; Jaentsch, O. (Siemens AG, Erlangen, Ger.). pp 263-9 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

It is very difficult to stabilize the noise and reverse characteristics of rod-shaped silicon detectors for medical application. They must function well in acids and other solutions without having a dense encapsulation. Therefore, special geometries of the end of the rod and surface protections were developed. Even for monoenergetic particles the detectors have a continuous spectrum, which decreases with increasing channel number. This can be explained theoretically by using an RC delay line as an equivalent circuit. (auth)

57809 ION IMPLANTED NUCLEAR PARTICLE DETECTORS. Sebillotte, Ph.; N'Docko, V. B.; Siffert, P. (CRN, Strasbourg). pp 302-18 of Proceedings of the Symposium on Semiconductor Detectors for Nuclear Radiation. Munich; Technische Universitaet (1970).

From Symposium on semiconductor detectors for nuclear radiation; Munich, Germany (11 May 1970). See CONF-700527.

Nuclear particle detectors made by boron implantation into silicon are described. Implant conditions are reviewed first. Then the electrical characteristics of the implanted crystal are discussed: these include sheet resistivity and effects of starting-material resistivity, doses, crystal orientation, and annealing on I-V characteristics for room-temperature implantation; implantation at 77°K is also briefly considered. The energy resolution and window thickness of the completed detectors are reported. At present, the main advantages of the ion-implanted detector seem to be its stability and the possibility of using classical transistor techniques to assure a better surface control. The performance of these detectors as nuclear particle spectrometers is similar to that of surface-barrier counters. (R.W.R.)

57810 COMPUTER ANALYSIS OF GAMMA-RAY SPECTRA. Tominaga, Hiroshi (Japan Atomic Energy Research Inst., Oarai, Japan). Radioisotopes (Tokyo); 20: No. 2, 93-101(Feb 1971). (In Japanese).

A review on computer analysis of gamma-ray spectra is presented. The review concerns a method to analyze isotopes by comparison with data of the same isotopes of a known amount. The amount of information from measurements of gamma-ray spectra has increased with the development of Ge(Li) detectors, so that computer analysis has become necessary. The first step of the analysis, smoothing and other treatments are applied, then the position and intensity of the gamma peaks are analyzed. The intensity is compared with data of standard sources by measuring the total or partial area of the peaks. The estimation of background intensity is an important problem and the subtraction of curved background is used in some cases. The peak function fitting method is used for complex peaks. Various functions such as the gaussian function and the exponential function and their combination are employed for this purpose. Search for the peaks is necessary before measurement of the peak intensity. The transfer averaging method, the smoothed first derivative method, and the smoothed second derivative method are used to search the peaks. Other mathematical methods are applied to find the peaks effectively. The response function method is employed to analyze the spectra taken by NaI(Tl) detectors. (Japan)

57811 HIGH PURITY GERMANIUM RADIATION DETECTORS. Drummond, W. E. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 91-100(Apr 1971).

The fabrication and characterization of high-purity-germanium radiation detectors are described. These detectors are n–i–p diodes with a shallow (1.5-μ) diffused junction and a noninjecting metal–semiconductor contact. The germanium has a net acceptor concentration of approximately 7×10^{11} cm^{-3}, and contamination during processing was prevented by using clean procedures and a KCN treatment. Electrical measurements show that with 500 volts of bias these detectors are fully depleted and have a capacitance of approximately 4.5 pF. Detection characteristics are determined from measurements of γ rays and x rays over the energy range from 6 keV to 136 keV. A deviation from linearity of less than ±0.2% was measured. The resolution of the detectors is characterized by an effective Fano factor of 0.12. The average energy expended per created pair was determined to be 2.95 ± 0.02 eV at 90°K. (auth)

57812 PULSED FEEDBACK TECHNIQUES FOR SEMICONDUCTOR DETECTOR RADIATION SPECTROMETERS. Landis, D. A.; Goulding, F. S.; Pehl, R. H.; Walton, J. T. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 115-24(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Methods of applying pulsed-charge feedback to the charge-sensitive preamplifiers used with semiconductor detectors are discussed. All have in common the accumulation of radiation-induced charge pulses on a feedback capacitor to produce a voltage ramp at the output of the feedback stage, which is reset at an appropriate point by pulsing a charge feedback path. Advantages of pulsed feedback over the conventional dc feedback techniques are discussed, together with the precautions required to reduce the effect of the large reset pulse on the later electronics. The application of pulsed-light feedback to low-energy x-ray spectrometers is discussed, and results are presented. Some aspects of this system that tend to limit its high-rate performance are also discussed. A brief account of the use of a transistor current-switch feedback system to reduce overload problems in high-energy γ-ray spectrometers is also given. (auth)

57813 MAGNETIC COMPTON SPECTROMETER FOR HIGH INTENSITY PULSED GAMMA RAY ENVIRONMENTS. Kelly, J. G.; Posey, L. D.; Halbleib, J. A. (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 131-41(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A magnetic Compton spectrometer is described which was designed to measure the gamma-ray spectra from distributed, intense pulsed sources in the presence of gamma-ray, electron, and/or neutron backgrounds. It was used to measure spectra of a nuclear device, the Sandia Pulsed Reactor, and the Hermes II flash x-ray machine. A discussion is given of the design features, the data reduction, and the results of the Hermes II measurement. (auth)

57814 PROGRESS IN THE FABRICATION OF γ-RAY DETECTORS FROM HIGH PURITY GERMANIUM. Baertsch, R. D. (General Electric Research and Development Center, Schenectady, N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 166-9(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A planar detector with a depletion layer width of 8 mm was fabricated from high-purity germanium. A total system resolution of 2.4 keV at 1.33 MeV was obtained with 600 volts bias on this detector. Another detector with a 3-mm-thick depletion region, which was operated at 2000 volts bias, yielded a system resolution of 1.65 keV at 1.33 MeV. Thin-window detectors were fabricated by using a glow discharge of BF_3 or PF_5. This technique has also been used to form ohmic contacts on high-purity germanium. (auth)

57815 CARRIER TRAPPING IN Ge(Li) DETECTORS. Sher, A. H. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 175-83(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The results of previously published studies relating to the trapping of charge carriers in semiconductor nuclear radiation detectors, including theoretical models and experimental data, are used to construct a more realistic operational model that can be used to describe the trapping process. Specifically, the model is developed for the situation most commonly reported in the literature, that of electron trapping in planar Ge(Li) detectors. The success of the present model is judged on its ability to predict the variation of the peak shape resulting from γ irradiation of a planar Ge(Li) detector as a function of applied bias. Full-energy γ-ray peaks are calculated with digital computation techniques by incorporating the variation of peak amplitude as a function of charge collection efficiency as well as the variation of carrier life-time with applied field into a previously published model. (auth)

57816 DETECTION OF LOW ENERGY X RAYS WITH Si(Li) DETECTORS. Jaklevic, J. M.; Goulding, F. S. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 187-91(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The continuing improvement in energy resolution of semiconductor-detector x-ray spectrometers has led to interest in the use of these devices at energies less than 2 keV. This is an energy region of potential analytical interest since the K x rays of several elements of biological and chemical importance occur at these energies. However, the low x-ray fluorescence yield in low-Z elements, combined with the absorption of low-energy x rays due to the entry window of the vacuum chamber and that of the detector, have made work in this energy region impossible with the standard semiconductor-detector x-ray spectrometers. In this work, the x-ray absorption path was reduced to a minimum to permit low-energy x-ray studies of excitation, entry-window thickness, detector linearity, and resolution. Measurements of characteristic K x rays of elements down to and including carbon (277 eV) were performed using electron beam excitation on low-Z targets. (auth)

57817 BARIUM FLUORIDE AS A GAMMA RAY AND CHARGED PARTICLE DETECTOR. Farukhi, M. R.; Swinehart, C. F. (Harshaw Chemical Co., Solon, Ohio). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 200-4(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Barium fluoride has been found to scintillate to gamma rays and alpha and beta particles. The scintillation performance and pertinent physical properties of BaF_2 are described in relation to some of the commercially available scintillators—NaI(Tl), CsI(Na), CsI(Tl) and CaF_2(Eu). The low-solubility, nonhygroscopic nature and a comparable absorption for gamma rays are particular advantages of BaF_2 over the alkali iodide scintillators. Transmission to its fluorescence emission, shorter decay time and a better photoelectric absorption cross section favor BaF_2 over CaF_2 scintillators. The scintillation pulse height of BaF_2, however, is presently lower than that of the other scintillators. The mechanism responsible for scintillation in BaF_2 is not well understood at present. Data seem to indicate that hole-centers may be playing a primary role in the scintillation emission. BaF_2 is usable for many applications that require a high-Z, nonhygroscopic scintillator. (R.W.R.)

57818 SLOW PULSES FROM GERMAINIUM DETECTORS. Sakai, Eiji (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 208-18(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Slow pulses from various types of Ge(Li) detectors, viz, a planar, a coaxial, a thin p^+-contact planar, and a "back-to-back" double planar detector, were studied by using a gamma-ray scanning technique and a risetime selector. A large and abrupt increase in the counting rates of the slow pulses were observed when the n^+-i and the i-p boundaries of these detectors were irradiated by a collimated gamma-ray beam. Slow pulses contributed to background counts in the pulse height distributions. Slow pulses from a deeply depleted n^+-p detector made from a high-purity p-type germanium crystal were also investigated. (auth)

57819 IMPROVED LIGHT OUTPUT FROM VERY THIN PLASTIC SCINTILLATOR. Kaiser, W. C. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 219-21(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Comparison tests conducted with standard Pilot B scintillator and Pilot B with 10 times the normal concentration of wave shifter show the latter to exhibit an output pulse $\sim 1\frac{1}{2}$ times as large when viewed with an RCA C31000D GaP first dynode photomultiplier tube. These results bear out a conclusion reached after analyzing the results of a previous study of plastic scintillators [Kaiser, W. C. and J. A. M. de Villiers, IEEE Trans., NS-11, No. 3, 29 (June 1964)]. (auth)

57820 SOME OBSERVATIONS ON GERMANIUM γ-RAY SPECTROMETERS MADE FROM HIGH PURITY p-TYPE MATERIAL. Sakai, Eiji; McMath, T. A.; Fowler, I. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 228-32(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Some properties of five germanium spectrometers made from two adjacent slices of a crystal of high-purity p-type germanium are described. Techniques used to put contacts on conventional Ge(Li) detectors were used, but found to be somewhat unsatisfactory for the high-purity material. (auth)

57821 LOW POWER CHARGE SENSITIVE AMPLIFICATION AND FAST COINCIDENCE SYSTEM FOR SPACE APPLICATION. Guenther, Godehard A. (Univ. of Alabama, Huntsville); Streeter, Gary. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 275-81(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A charge-sensitive FET amplification and coincidence system for solid-state detectors and random counting rates of 350,000/sec is described. The fully depleted Si surface-barrier detectors are dc-coupled to the FET input stages of the preamplifiers, which produce pulses of 30 ns risetime with a 100 ns decay constant. The postamplifiers are integrating and differentiating, and generate negative-going bipolar pulses of 1 μs length. The dynamic range goes from 25 mV to 5 volts at a stability of 3% over a temperature range from −30°C to +50°C. With 60 pf input capacity the noise is 38 keV. A set of threshold discriminators rejects noise and strobes the subsequent zero-crossover detectors. The outputs are square pulses, which activate a 40-ns tunnel diode coincidence circuit. The power consumption of the complete system is 150 mW. Miniaturized PC board construction is used for packaging. (auth)

57822 SPECTROMETRIC CHARACTERISTICS OF GERMANIUM DETECTORS WITH RADIATION DEFECTS. Stolyarova, E. L.; Volodin, S. N.; Platov, A. I.; Samedov, V. V. (Inst. of Engineering Physics, Moscow). pp 277-85 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The results of studies on the spectrometric characteristics of a germanium detector based on radiation defects are presented. The valuable properties of detectors of this type are that they can

XUM

be stored at room temperature and repeatedly cooled to 70°K and heated to 300°K. They have a thin dead layer, so that they can be used extensively in the measurement of low-energy gamma rays and characteristic X-rays. The detector was studied in a gamma-spectrometer system with a charge-sensitive low-noise preamplifier. The basic characteristics of the detector are given. The linearity of the spectrometer lies within experimental errors in the energy range investigated, i.e. 122 to 1333 keV. Data are also given from studies on the relationship between photo-contribution and gamma-ray to energy, together with the author's evaluations of the life-time and relative loss of charge carriers. (auth)

57823 COMPARISON AND ANALYSIS OF THE PARAMETERS OF CLINICAL WHOLE-BODY SPECTROMETERS. Fedrorov, G. A.; Konstantinov, I. E.; Slavyagin, P. D.; Moiseev, I. F.; Antonov, V. A. (All-Union Research Inst. for Instrument Making, Moscow). pp 579-90 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The parameters of four types of clinical whole-body spectrometers (eight-crystal spectrometer—four crystals above and four crystals under the patient; two-crystal spectrometer with linear scanning geometry; two-crystal spectrometer with spiral scanning geometry and with a possible termination and without any termination of the forward probe movement at the ends of the phantom) are compared from the point of view of two basic characteristics required of such spectrometers: (1) The spectrometer should have uniform spatial sensitivity, i.e. pulse counts should be independent of isotope localization in the organism; and (2) It should have maximum sensitivity relative to the number of detectors required for meeting the first requirement. An M-20 computer was used for calculating the efficiency of counting the primary gamma radiation from isotropic point sources of ^{125}I, ^{141}Ce, ^{51}Cr, ^{131}I, ^{137}Cs, ^{60}Co, and ^{40}K placed at 13 points of each of the 18 sections (every 10 cm) of a water-filled elliptical cylinder 180 cm in length and with 36 cm and 20 cm axes, for the four above-mentioned measurement geometries. Results were obtained for different measurement geometries. The calculations were verified experimentally by an eight-crystal spectrometer. From an analysis of the results, the optimum measurement geometry for the four types of spectrometers was determined. It is shown that the uniformity of spatial sensitivity can be considerably improved if the entire spectrum of gamma radiation from the phantom is recorded. (auth)

57824 NUTATION NMR STABILIZER FOR BETA-SPECTROMETER MAGNETIC FIELDS. Stakhov, O. V. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 4, 50-6(Jul-Aug 1969). (In Russian).

A stabilizer, based on the phenomenon of mutation (NMR), for nonhomogeneous magnetic fields of $\pi\sqrt{2}$ beta spectrometers with an equilibrium-orbit radius of 500 mm is described. The schematic diagram of the stabilizer, the design of the thermostatically controlled analyzer, and the variable-volume-field recorder are given. The stabilizer permits the stabilization of nonhomogeneous fields with a high accuracy ($\sim 10^{-5}$), and can be used with slight alterations for field stabilization in spectrometers of other types. (tr-auth)

High Energy Physics Instrumentation

Refer also to abstract 58822.

57825 (RPP/H–81) SIMPLE IONIZATION MEASURING DEVICE FOR BUBBLE CHAMBER PICTURES. Bairstow, R.; Brandstetter, A.; Hunt, J. H. (Rutherford High Energy Lab., Chilton (England)). Aug 1971. 12p. Dep. NTIS (U. S. Sales Only).

A small self-contained device for the measurement of ionization in bubble chamber pictures has been developed at the Rutherford High Energy Laboratory. A description of the instrument and results of ionization measurements are presented and the possible use of this instrument as an aid for monitoring bubble chamber exposures is discussed. (auth)

57826 (SJC-T-71-3) OPTICS OF THE 75 cm HYDROGEN BUBBLE CHAMBER. [PART] I. Matur, H.; Nakajima, K.; Yoshimura, Y. (Tokyo Univ. (Japan). Inst. for Nuclear Study). Mar 1971. 25p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The design of an optical system for a 75 cm hydrogen bubble chamber is presented. Three cameras are employed to take stereo photographs. A bright field system is used because of technical problems in making glass for windows and lenses. Three lenses were designed by taking high resolution, small distortion, no movement of pupils, and small diameter into consideration. The lenses were composed of seven glasses, and designed to have a focal length of 74.95 mm and an iris diaphragm of F/8 to F/32. The distortion aberration was less than 0.007% for d line, and the resolution was more than 100 lines/mm. The distortion was measured with Moire fringes, and was less than 0.014%. The measured focal length was 74.70 ± 0.05 mm. The cameras for the bubble chamber are pulsed cameras. Driving of the cameras must be finished within 100 m sec, since two photographs should be taken during one cycle of an accelerator. A xenon gas flash tube was used for a light source. Scotchlite SPR 1042 (Minnesota Mining and Manufacturing) was used for the present purpose. High resolution was required for films, and minicopy film HR (Fuji Film Co.) was used. The resolution was 340 lines/mm. (Japan)

57827 PRESENT STATUS OF AUTOMATIC ANALYSIS OF BUBBLE CHAMBER PHOTOGRAPHS. Yamagata, Taketora (Tokyo Metropolitan Univ.). Oyo Butsuri; 40: No. 4, 348-57 (Apr 1971). (In Japanese).

The present status of automatic analysis of bubble chamber photographs is reviewed. The analysis of bubble chamber photographs has been a serious problem in elementary particle physics, because it was necessary to analyze one million pictures in a year. Several methods of the automatic analysis were developed. HPD (Hough–Powell Device) has been widely used. The speed of the scanning is 400 lines per second, and it takes 6 seconds for scanning one film. Three alternative processes are necessary before the scanning by HPD. One is road guidance which is a method of rough manual digitization of position of vertex and track. The second method is vertex guidance that is a method of rough digitization of the position of vertex only. The third method is zero guidance which means no predigitization, and this method is under development. Spiral readers are also used as well as the HPD. This device scans films spirally from a vertex. The vertex guidance is necessary before the scanning. A device named CAMP (Computer-Aided-Measuring-Projector) which is composed of a rough digitizer and a small computer is also described. Scanning is performed with a slit. Recently, devices using a cathode ray tube have been developed. The motion of spots of these devices is easily controlled at high speeds by a computer. (Japan)

57828 STUDY OF LARGE-AREA, FLAT SCINTILLATION DETECTORS. Ivanenko, V. M.; Moldabaev, E. K. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 4, 45-9(Jul-Aug 1969). (In Russian).

A study of scintillation detectors 0.25, 0.5, and 1 m^2 in area is reported; they are used in experiments for the study of high-energy nuclear interactions of cosmic rays. The light collection of the scintillation detectors, which use trapezoidal air light pipes of constant cross section, was studied. The average measured pulse-height resolution of the meter scintillation detector is 85%, with the intrinsic scintillator resolution being 16%. The coefficient of the inhomogeneity of light collection, relative to the PM quantity, varies from 12 to 53%. The average measured coefficient of attenuation for the scintillations is equal to 0.015 cm^{-1}. (tr-auth)

57829 SENSITIVITY OF NUCLEAR EMULSION AT VERY LOW TEMPERATURE. Johnson, A. W.; Hebert, C. J. D.; Hebert, J.; Lamarche, J. L. G. (Univ. of Ottawa). Can. J. Phys.; 49: No. 19, 2524-6(1 Oct 1971).

The sensitivity of Ilford G5 emulsion was studied at very low temperature by comparing the grain density of proton tracks recorded at 0.1°K and at room temperature. It is found that the emulsion retains (74 ± 2)% of its room temperature sensitivity when exposed at 0.1°K and that temperature cycling has no noticeable effect on previously recorded tracks. (auth) (Canada)

Radiation Dosimeters

Refer also to abstracts 57776, 58010, 58012–58017, 58019, 59147, and 60160.

57830 SPECIFICATION FOR DIRECT-READING PERSONAL DOSEMETERS FOR X- AND GAMMA RADIATION. British Standard 3385 1961. London; British Standards Institution (1961). 8p. Available from American National Standards Institute, New York.

A standard prescribing requirements for the design of personnel quartz-fiber pocket ionization chamber for the measurement of integrated x and gamma radiation exposure doses in roentgens is presented. (W.H.K.)

57831 RADIATION DOSIMETER HAVING SENSITIVE MATERIAL CONTAINING LITHIUM HYDRIDE. **Oberhofer, Martin; Jaspert, Jurgen (to EURATOM).** U. S. Patent 3,577,161. 4 May 1971. Priority date 21 Dec 1966, Netherlands.

A radiation dosimeter based on thermoluminescence is described. The sensitive material in the dosimeter is, at least in part, lithium fluoride, and to the sensitive material is added lithium hydride. (auth)

57832 METHOD FOR READING A THERMOLUMINESCENT DOSIMETER. **McCall, Richard C. (to United States Atomic Energy Commission).** U. S. Patent 3,582,652. 1 Jun 1971. Filed 12 Jan 1970.

A method for reading the exposure of radiation sensitive thermoluminescent material to x-radiation or radiation from a radioactive source is described. The method comprises the steps of very rapidly heating the material to a temperature slightly above the temperature of peak luminescence, evenly maintaining the material at the attained temperature for a period that extends at least to the termination of luminescence of the material, and sensing the total luminescence of the material. (auth)

57833 LUMINESCENCE AND EXOELECTRON DOSIMETRY IN PERSONNEL MONITORING. **Attix, F. H. (Naval Research Lab., Washington, D. C.).** pp 3-15 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The acceptance of luminescence (especially thermoluminescence) dosimeters for routine γ- and β-ray monitoring has been progressing in a number of establishments, and the development of automatic read-out equipment will no doubt accelerate this process. A number of useful dosimeter phosphors are available for this application; however, lithium fluoride continues to be the most widely employed. In the area of neutron dosimetry, luminescent dosimeters have not been so successful, because they are insensitive to fast neutrons. Various methods have been attempted to overcome this deficiency, and these are discussed. It is pointed out that it should be possible to achieve a useful luminescent dosimeter for registering the combined γ-ray + intermediate neutron dose by adjusting the thermal-neutron/γ-ray response ratio. Several recent attempts at achieving a more acceptable fast-neutron response are discussed, including one based on an exoelectron emission dosimeter. (32 references) (auth)

57834 INVESTIGATIONS ON EXOELECTRONS WITH A SPECIAL PROPORTIONAL COUNTER. **Kriks, H. J. (Physikalisch-Technische Bundesanstalt, Brunswick).** pp 17-24 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

A proportional counter of pill-box type working with methane as counting gas was developed as a detector for exoelectrons. The mechanical construction of the device allows both optical and thermal stimulation of exoelectrons. The counting properties of the detector were investigated with special emphasis on its suitability for detecting low-energy exoelectrons. The plateau for a ^{63}Ni betasource inside the counter has a rise of about 4% per 100 V over a range of 500 V. The dead-time is less than 2 μs, and the counting rates at a cathode voltage of 3700 V proved to be sufficiently constant even when the temperature at the sample surface was more than 400°C. With this device the thermally stimulated exoelectron emission (TSEE) from beryllium oxide irradiated with ^{60}Co gamma rays has been studied. The results show that it is possible to obtain a response sufficiently proportional to exposure in the range from 2 mR up to 2 R with BeO powder without adding graphite. A mixture of 15% BeO and 85% graphite powder extends the proportionality range to 500 R. Combining BeO exoelectron dosimeters of different BeO contents should give applications in both routine dosimetry and emergency situations. (auth)

57835 NEW EXOELECTRON DOSIMETERS. **Becker, K.; Cheka, J. S.; Crase, K. W.; Gammage, R. B. (Oak Ridge National Lab., Tenn.).** pp 25-36 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Two techniques for preparing highly sensitive, mechanically and chemically resistant, inexpensive and well reproducible detectors based on the thermally stimulated exoelectron emission (TSEE) from small polycrystalline, sintered BeO discs were studied. In one method, the discs are impregnated by controlled thermal diffusion with inert high-melting metals such as Pt, Pd and Au for increasing the electrical conductivity and reducing the work function of the surface. In the second, superior method, the BeO discs are sensitized by heating in air at temperatures up to 1400°C. The high sensitivity is retained during storage in air. Immersion in water reduces the sensitivity, which can be fully restored by re-heating. If proper care is taken, either by protective framing of the detectors or by a special design of the reader, even small doses (<1 mR) can be measured with good reproducibility ($\sigma = 2\%$ to 5%). Fast neutrons can be measured as the response difference between detectors covered with polyethylene and with Teflon. The detection limit is <1 mrad, the energy response satisfactory. (auth)

57836 HIGH-SENSITIVITY THERMALLY STIMULATED EXOELECTRON EMISSION ELEMENT FOR GAMMA DOSIMETERS. **Beskorskii, A. I.; Zhegalina, G. A.; Kuz'min, V. V.; (and others) (All-Union Research Inst. for Instrument Making, Moscow).** pp 37-43 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

A new method of dosimetry based on thermally stimulated exoelectron emission is discussed. The design of a series-produced element of the DE-1G type and its basic parameters including slope of the plateau of the counting-rate curve, amplitude characteristic, dead time, reproducibility of readings, scatter of sensitivity in a batch of elements, dose characteristic, fading and energy dependence are described. The technology of producing the exoelectron emitter and the element is briefly described. The construction of the element in the form of a sealed gas-discharge counter made it possible to obtain ±3% reproducibility of readings for a sensitivity of 300 pulses per 1 mR and a background of 0.1 mR. (auth)

57837 SURFACE DOSIMETRY USING THERMOLUMINESCENT DISCS. **Gibson, J. A. B.; Marshall, M.; Docherty, J. (United Kingdom Atomic Energy Authority, Harwell, Eng.).** pp 45-57 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Lithium fluoride loaded into Teflon discs of thickness 9 mg$\cdot$cm^{-2} forms a very convenient dosimeter for measuring surface dose rate from beta and gamma radiation. Stacks of thin dosimeters have been used in many special experiments, for example, measurement of the dose to the fingers from ^{82}Br in silica glass vials, and the maximum gamma-ray dose estimation from nuclear heat sources using ^{238}Pu. In both cases the calculated dose agreed with the extrapolated surface dose from the TLD stacks. This has confirmed that theoretical methods can be used to give an early estimate of overexposure, particularly where the incident cannot be reproduced experimentally. (auth)

57838 IAEA INTERNATIONAL GLASS DOSIMETRY INTERCOMPARISON, 1970. **Dorofeev, G. A.; Somasundaram, S. (International Atomic Energy Agency, Vienna).** pp 59-66 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Assessments of the reliability and accuracy of measurement of gamma radiation fields used for calibration purposes were initiated by mailing radiophotoluminescent glass dosimeters to twenty Member States' laboratories; after irradiation these were returned to IAEA for measurement. It was found that in some laboratories the accuracy of measurement is outside the limits prescribed in the ICRP Recommendations. This experiment helped the laboratories to check and correct their calibration procedures, and the work will be extended to all IAEA Member States interested in keeping their secondary standard calibrations at an internationally acceptable accuracy. (auth)

57839 SEALED THERMOLUMINESCENT DOSIMETER EMPLOYING R. F. HEATING FOR ROUTINE INDIVIDUAL MONITORING. **Brunskill, R. T. (United Kingdom Atomic Energy Authority, Sellafield, Eng.); Langmead, W. A.** pp 67-76 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

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The indications for thermoluminescence dosimetry in various types of individual monitoring are reviewed. It is concluded that TLD is the system of choice for many applications provided that a simple dosimeter design is available that is capable of automated dose read-out. A two-element dosimeter is described incorporating graphite trays contained in a Tufnol and Teflon body. The thermoluminescent material, at present lithium borate or fluoride, is attached to the graphite trays in a solid matrix of non-luminescent adhesive, and is covered by a window of FEP film. Read-out is achieved by eddy current heating of the graphite by R.F. energy fed to a small water-cooled coil below the dosimeter, thus making unnecessary any handling of the TL material. The response characteristics of the dosimeter to various radiation types and energies are given. Proposals for a dosimeter system providing simultaneous read-out of surface dose and dose from the penetrating component of the radiation are made. (auth)

57840 DEVELOPMENT OF THERMOLUMINESCENCE DOSIMETRY SYSTEMS AT AEE WINFRITH. Johns, T. F.; Peabody, C. O.; Preston, H. E.; Perry, K. E. G. (Atomic Energy Establishment, Winfrith, Eng.). pp 77-90 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Operational experience with thermoluminescence dosimeters at AEE Winfrith has shown that technically thermoluminescence dosimetry is an acceptable method for the measurement of doses to the trunk of the body. Details are given of the dosimeters which have been used and of the results which have been obtained. While the devices which have so far been used are satisfactory for use on small or medium scale, they are not suitable for use on a very large scale because of difficulties associated with the data handling. A more sophisticated badge is being developed which is intended to overcome these difficulties. It is hoped that this might ultimately prove to be an acceptable alternative to (or even a replacement for) the film badge, for use on a very large scale. Details are given of progress made in overcoming some of the difficulties still associated with this concept. (auth)

57841 NEW THERMOLUMINESCENCE DOSIMETER OF HIGH SENSITIVITY USING A MAGNESIUM SILICATE PHOSPHOR. Hashizume, T. (National Inst. of Radiological Sciences, Chiba, Japan); Kato, Y.; Nakajima, T.; (and others). pp 91-100 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The thermoluminescence dosimeter (TLD) is now widely used for dosimetry of various kinds of radiation. The phosphors at present available for TLD are classified into two groups, one of which, for instance LiF, is excellent in tissue equivalence, but is inferior in sensitivity. The other group possesses high sensitivity, but is much inferior in tissue equivalence. Examples are $CaSO_4$: Mn(Dy) and CaF_2: Mn. Therefore it was decided to develop a new phosphor which meets the requirements of both tissue equivalence and sensitivity. This phosphor has the composition Mg_2SiO_4 and includes a small amount of Tb^{3+} as activator. Its various properties as a dosimeter and other physical aspects are described. Most experiments were carried out using glass tubes of 2.0 mm in diameter and 10 mm in length in which the phosphor was sealed under a rare gas. In some cases dosimeter elements embedded in plastics were also used. Outstanding characteristics are as follows: (1) The dosimeter is responsive to X and gamma rays over a wide range of dose (0.1 mR to 10^4 R). The sensitivity is 100 times that of LiF (a commercial product); (2) The energy dependence is much less than that of $CaSO_4$: Mn(Dy) or CaF_2: Mn, which belong to the group of high-sensitivity phosphors. For instance, the sensitivity to 38 keV (eff.) X-rays is four times that for ^{60}Co gamma rays. Moreover, this dependence is easily reduced to less than 1.3 by means of a tin filter; (3) The effective atomic number is 11.0; (4) The glow curve is simply shaped peaking at about 200°C. The fading after keeping for 60 days at room temperature is less than 3%. It is concluded that this phosphor, with its distinctive properties, will prove of value in dosimetry. (auth)

57842 COMBINED LITHIUM BORATE AND LITHIUM FLUORIDE THERMOLUMINESCENCE DOSIMETER FOR ROUTINE PERSONAL MONITORING. Christensen, P. (Danish Atomic Energy Commission Research Establishment, Risoe). pp 101-12 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Hot-pressed, 25 mg lithium-7 fluoride dosimeters (Harshaw) and sintered, 25 mg lithium borate dosimeters were compared and studied for application to routine personal monitoring. The lithium borate phosphor was prepared at Risö from lithium tetraborate with small additions of manganese and quartz and it was formed into tablets by means of an automatic tabletting machine. The sensitivity ratio LiF/$Li_2B_4O_7$: Mn, Si was measured to be 3/1 with an Sb/Cs photomultiplier tube. The study of the two dosimeter types covered fading, annealing requirements, energy dependence on photon and beta radiation, re-use, neutron sensitivity, sensitivity to light, precision of low-dose measurements, etc. Plastic capsules each containing two ^{7}LiF and two $Li_2B_4O_7$: Mn, Si dosimeters were worn as personal dosimeters, in addition to their film dosimeters, by people working in reactor facilities and other areas. Good agreement between the two types of TL dosimeters was obtained for dose measurements in neutron-free areas. In reactor buildings a small overdose effect caused by neutrons was shown by the borate. The data showed poor agreement between TL and film dosimeters. A personnel dosimetry system consisting of two $Li_2B_4O_7$: Mn dosimeters for normal routine beta and gamma monitoring and one ^{7}LiF dosimeter used as a long-term dosimeter and as a safeguard against false readings due to thermal neutrons seems to make the most of the advantages of both $Li_2B_4O_7$: Mn (low production cost, no annealing requirements after the read-out process) and ^{7}LiF(no fading, good accuracy, low sensitivity to thermal neutrons). The three dosimeters were assembled in a badge intended for routine personal monitoring, and the system was investigated for its energy and angular dependence with photon and beta radiation. (auth)

57843 READ-OUT INSTRUMENTS FOR SOLID THERMOLUMINESCENCE DOSIMETERS, USING HOT NITROGEN GAS AS THE HEATING MEDIUM. Boetter-Jensen, L. (Danish Atomic Energy Commission Research Establishment, Risoe). pp 113-24 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Two thermoluminescence dosimeter (TLD) readers with hot nitrogen gas as the heating medium were designed for measuring solid TLDs. The main advantages of nitrogen heating over traditional heating systems are: (1) a minimum of black-body emission on account of a fixed gas temperature and the absence of mechanical heating elements; (2) a very reproducible heating procedure as the dosimeters are completely surrounded by the heating medium; and (3) a convenient feeding procedure permitting a large number of dosimeters to be measured in a short time. One reader was designed for measuring solid dosimeters of different shapes and sizes. The other was designed to measure small dosimeters only, e.g. Harshaw Chemical Company's 25 mg hot-pressed LiF dosimeters (3 × 3 × 0.8 mm). The design of the read-out chambers, the dosimeter feeding system and the gas temperature control arrangement are described. Based on one year's operational experience, the performance of the hot-nitrogen read-out technique is discussed. Measurements were carried out to demonstrate the advantages of nitrogen heating, and investigations on the proper adjustment of gas flow and gas temperature were made in order to achieve maximum efficiency and economy. The TL equipment incorporates instrumentation for automatic print-out of the results on a Teletype printer and punched tape for data processing in a computer. Furthermore an automatic sample changer facility is planned for use with a TLD badge containing four dosimeters (LiF and $Li_2B_4O_7$: Mn, Si) marked with a binary identification code. The prototype of the badge is discussed. TL equipment with nitrogen gas heating was used at Risö for eight months for personnel dosimetry, environmental monitoring and other routine measurements. It proved to be very reliable and, moreover, the read-out procedure was very convenient. (auth)

57844 EFFECTS OF RESIDUAL THERMOLUMINESCENCE IN FLUORITE AND LITHIUM FLUORIDE THERMOLUMINESCENT DOSIMETERS. Sunta, C. M.; Kathuria, S. P. (Bhabha Atomic Research Centre, Bombay). pp 125-33 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Natural CaF_2 (fluorite) thermoluminescent dosimetry (TLD) phosphor has five main glow peaks from room temperature to 600°C. Normal reading of dosimeter does not require heating above about 300°C, which therefore leaves the high temperature glow peaks unaffected. This unreleased part of the glow curve is called residual thermoluminescence (RTL). The effect of RTL on sensitivity and linearity is studied. Quantitative measurements are done for gamma exposure sensitivity as a function of RTL. Different magnitudes of RTL were built up by giving suitable reactivating gamma exposures after heating the sample at 600°C to completely release the natural TL. It is found that gamma exposure sensitivity as well as RTL are maximum with reactivating exposures of about 10^5 R. It is seen that gamma sensitivity is about 2.5 times more in a sample with saturated RTL than in that with no RTL. However, the linearity of latter type extends to about 3.5 times higher exposures than in former. A TLD grade fresh natural fluorite sample when heated at 400°C provides a phosphor with saturated RTL and that heated at 600°C gives one with no RTL. The former is more suitable for low radiation measurements and the latter for high levels. Presence of high temperature glow peaks is shown also in LiF TLD phosphors. Importance of RTL peaks in determining the pre-exposure annealing temperature is indicated. It is shown that the effects of RTL are similar in fluorite and LiF TLD phosphors. (auth)

57845 THERMOLUMINESCENCE DOSIMETRY STUDIES AT THE PHILIPPINE ATOMIC RESEARCH CENTER. Bustamante, Norma T.; Bartolome, Z. M. (Philippine Atomic Research Centre, Manila). pp 135-44 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Thermoluminescence dosimetry studies have been initiated at the Philippine Atomic Research Center of the Philippine Atomic Energy Commission. A recalibration of the equipment indicates a divergence from supplied calibration curves, especially with regard to the dark current. Operating currents and heating temperatures also show a statistical uncertainty of approximately 7%. Gamma-dose calibrations were undertaken using a ^{60}Co gamma garden previously mapped with an R-meter and chemical dosimeters. Neutron dose calibrations have been attempted using the Philippine research reactor. Some isodose curves in a dry gamma room from a 20,000 Ci ^{60}Co source inside the PRR-I reactor pool are presented. Both unannealed LiF and annealed LiF were studied. (auth)

57846 SOME NEW DEVELOPMENTS IN DOSIMETRIC DETECTORS. Ivanov, V. I. (Inst. of Engineering Physics, Moscow). pp 145-8 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

A definition of the category of dosimetric detectors and the principal dosimetric quantities are given. Some new developments in these detectors are reviewed. There is a description of a calorimetric method developed in the USSR for the simultaneous determination of composition and dose-rate in the case of mixed gamma-neutron radiation which uses a single calorimetric substance. The merits of a quartz detector are indicated, and the use of direct-charge detectors for dosimetric purposes are discussed. Also, the possibility of using a solution of glucose in water for in-pile dosimetry is mentioned. (auth)

57847 NEW HIGH-SENSITIVITY THERMOLUMINESCENT DOSIMETER FOR SHORT-TERM PERSONNEL DOSIMETRY. Webb, G. A. M. (Teledyne Isotopes, Westwood, N. J.). pp 149-57 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

A new dosimeter is described which is capable of dose measurement down to sufficiently low levels for personnel to be monitored on a daily or hourly basis if required. However, unlike other low-level dosimeters previously in use, the fading of the stored signal is small enough for this effect to be neglected in routine use. Applications of the new dosimeter include the assessment of doses received by visitors to a nuclear site before they have left the site boundary with very much greater accuracy and reliability than is possible using conventional condensor chambers (Q.F.E.'s). The new dosimeter consists of a dispersion of calcium sulphate: dysprosium thermoluminescent dosimetry phosphor in Teflon (PTFE). The resulting dosimeter can detect doses of less than 1 mrad and has acceptable fading of the stored signal at environmental temperatures. Data are presented on the precision of the dosimeter at various dose levels, the linearity of the response with dose, the fading of the stored signal as a function of time and temperature, and the sensitivity to natural and artificial light levels. An installation is described suitable for use by unskilled personnel which would permit monitoring of visitors to a nuclear site or a nuclear area. The main feature of the installation is the capability to immediately measure actual doses received down to meaningful levels for an exposure of only a few hours at low dose levels. (auth)

57848 LiF RADIOTHERMOLIMINESCENT DOSIMETERS WHICH CAN BE REUSED WITHOUT REGENERATION. Portal, G.; Bermann, F.; Blanchard, Ph. (CEA, Fontenay-aux-Roses, France). pp 159-72 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The lithium fluoride now available commercially possesses very valuable properties for radiological safety measurements and it would be of interest to use it for routine measurements. Its use does, however, give rise to problems, firstly due to the instability of the traps located close to the surface and secondly as the material has to be regenerated after each reading. A process has been developed for producing lithium fluoride which is free of this defect and which can be reused a considerable number of times without any appreciable alteration in its properties. The sintering procedure developed for economic production on an industrial scale is described and the essential characteristics are given. (auth)

57849 SENSITIVE ELEMENT FOR RADIOTHERMOLUMINESCENT DOSIMETERS FOR GAMMA AND NEUTRON RADIATIONS. Kuz'min, V. V.; Mysev, I. P.; Sokolov, A. D. (All-Union Research Inst. for Instrument Making, Moscow). pp 173-9 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Methods of measuring the equivalent dose of mixed gamma and neutron radiation based on the use of radiothermoluminophors which exhibit high sensitivity in the recording of heavy charged particles are described. The sensitive element of a dosimeter for making such measurements is designed in the form of a disperse system consisting of a calcium sulfide luminophor and heat-resistant hydrogenous base. The results of measurements of the basic dosimetric parameters of the element are given: Sensitivity to gamma rays and neutrons as a function of luminophor concentration; The standard deviation of sensitivity in a batch of elements with luminophor concentration of 300 mg/cm^3 is ±7.4%; The dose characteristic is linear in the equivalent dose range from 50 mrem to 5 krem; Sensitivity of the element to X-radiation with an effective energy of 40 keV is fifteen times higher than its sensitivity to the gamma radiation of ^{60}Co, but the energy dependence obtained with an 0.64 mm lead filter does not exceed ±20% in the 1000 keV-1.25 MeV energy range; Dependence of the sensitivity of the element to 1 rem equivalent for measurements in the 50 keV-4.5 MeV neutron energy range. The tests carried out with the elements confirm that the method can be used extensively for measuring the dose of mixed gamma and neutron radiations in the case of chronic exposure or severe radiation injury. (auth)

57850 DOSIMETRIC CHARACTERISTICS OF SILICON DETECTORS FOR GAMMA RADIATION. Stolyarova, E. L.; Volodin, S. N.; Samedov, V. V.; Frolov, S. G. (Moscow Engineering Physics Inst.). pp 269-76 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Silicon semiconductor detectors possess properties which are very advantageous in dosimetry-high sensitivity per unit volume, fast action, low bias voltage, high mechanical strength, low sensitivity to magnetic fields, sufficient radiation stability, compactness and light weight. The results of studies on the dosimetric characteristics of silicon diffusion drifted detectors for gamma rays are given. The studies were carried out in a gamma-spectrometer system and on a model of the dosimeter, in which a discriminator was used in order to cut off the noise of the detector-amplifier system. Data are given on energy dependence and on the effect of rectifier filters and discriminator level on energy dependence. It is concluded from the experiments that detectors of this type can be used in gamma dosimetry in the 0.1 to 1.33 MeV energy range and in a wide range of dose rates. (auth)

57851 DETECTOR FOR THE MEASUREMENT OF DOSE DISTRIBUTIONS AT A BONE-TISSUE INTERFACE. Poston, J. W. (Oak Ridge National Lab., Tenn.). pp 299-310 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Radiation detectors are described which facilitate the measurement of dose distributions at a bone-tissue interface. These small extrapolation-ionization chambers allow the measurements of dose distributions at depths in tissue-equivalent phantoms, a significant improvement over dosimeters of this general type. Such measurements allow a more accurate assessment of the importance of this interface in the establishment of external radiation exposure standards. Detector characteristics, such as saturation voltage as a function of electrode spacing, directional response of the chambers, and effects of change in collecting electrode area, are discussed. A method for measuring ionization currents produced in these chambers at large distances from the point of measurement is presented. Results of measurements in a tissue-equivalent phantom are presented for neutrons from several isotopic sources, i.e., AmB, AmBe, and PuBe. Dose distributions from a 14 MeV neutron source are given also. The significance of these results in relation to theoretical studies and the present exposure standards is discussed. (auth)

57852 DOSIMETRIC APPLICATIONS OF ELECTRONIC PARAMAGNETIC RESONANCE MEASUREMENTS OF FREE RADICALS FORMED IN AMINO ACIDS: CONSTRUCTION OF A TISSUE-EQUIVALENT DOSIMETER BASED ON ALANINE. Bermann, F.; De Choudens, H.; Descours, S. (Commissariat a l'Energie Atomique, France). pp 311-25 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

In the case of amino acids, rupture of the molecules due to the action of radiation is found to produce free radicals. The number of these radicals can be measured by means of an electronic paramagnetic resonance spectrometer and this number is proportional to the dose absorbed. Alanine has been used for this purpose since it possesses this property over a wide dose range (from 10 to 5×10^6 rads). The following points are studied: (a) Pre-irradiation effect in non-irradiated alanine: this dose limits the minimum measurable dose to approximately 10 rads. The origin of this dose and means of reducing it have been studied; (b) Energy response of the alanine: by virtue of the close similarity of its composition to that of tissue, this dosimeter has a good energy response for gamma radiations; the loss of efficiency at low energies can be corrected by the addition of a higher Z material (Ba or Ca); (c) Response to neutrons: with neutrons the radical yield is lower than in the case of gamma radiation, although this yield can be increased by adding a hydrogenated substance (paraffin); and (d) Construction of a dosimeter in pellet form: the addition of paraffin improves the response to neutrons and enables moulded pellets of the mixture to be produced. These are easier to use than alanine in powder form and the dosimeters can be produced in any desired form. (auth)

57853 STUDY OF A TISSUE-EQUIVALENT SPHERICAL PROPORTIONAL COUNTER. Dmitrievskii, I. M.; Lysak, Yu. D.; Frolov, V. V. (Inst. of Engineering Physics, Moscow). pp 335-42 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The results of a study on the properties of a Rossi-type proportional counter are presented and it is proposed that they be used as a basis for a new design, characterized by both simplicity and reliability. The conditions under which the counter can be used for measuring dose spectra in terms of LET are considered. A number of new and simple methods of processing recorded spectra and determining the effective value of the quality coefficient are proposed; the error of the results is evaluated. (auth)

57854 NEUTRON DOSE ESTIMATION USING A NATURAL URANIUM FISSION FRAGMENT TRACK PERSONNEL DOSIMETER. Gomaa, M. A. Hassib, G. (Atomic Energy Establishment, Cairo). pp 343-7 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The idea of using a natural uranium fission fragment track dosimeter, in the neutron field of thermal, intermediate and fast neutrons in air, has recently been introduced. The system can be used for thermal neutron dose estimation as well as intermediate plus fast neutron dose estimation if the spectrum and the percentage contribution of each neutron group is known. Feasibility of the use of such dosimeters when they are worn by radiation workers is investigated. Detailed study of the system shows the possibility of differentiating between doses received from fast, intermediate and thermal neutrons if one takes into account reflection from the body of thermal, intermediate and fast neutrons. (auth)

57855 APPLICABILITY OF TRACK DETECTORS IN NEUTRON DOSIMETRY. Burger, G.; Gruenauer, F.; Paretzke, H. (Institut fuer Strahlenschutz, Neuherberg, Ger.). pp 349-58 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

In spite of evident advantages in comparison with nuclear track film, the non-photographic track detectors have not yet found a wide application in practical dosimetry. This was partially due to the complicated methods of track counting with microscopes, which can be avoided by using spark-counters of the "Cross" type. A suitable improved counter is discussed and experience gained in its practical use is reported. The data refer to the reliability of the counting system, to the detector foils used and their dependence on environmental conditions. For some fission foils, the effective dose responses for certain calibration spectra and various assumed leakage spectra have been calculated and, in part, measured. Some theoretical aspects of using different neutron conversion reactions, which affect the dosimetric information obtained, are discussed. (auth)

57856 SETTING-UP OF A NEUTRON DOSIMETER USING IONOGRAPHIC TRACKS IN AN INSULATING SOLID. Carfi, N.; Dugnani Lonati, R.; Mangialajo, M. (Centro Informazioni Studi Esperienze, Milan). pp 359-63 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The use of dielectrics such as mica, glasses and plastic materials for charged particle track recording has been developed in the past years; track recording of fission fragments produced in fissile materials under neutron irradiation is particularly interesting. The method has not as yet been applied to neutron dosimetry owing to the difficulties of track observation and counting using optical microscopes. A method has recently been proposed which results in markedly reduced counting times by electronic counting of the electric discharges between two electrodes through the dielectric which was perforated by the fission fragments. The reasons for adopting this new technique to set-up a neutron dosimeter are: (a) economic advantages, since a rather simple electronic instrumentation will give a reading of the dosimeter, preparation of which can be carried out immediately and at a modest cost; (b) fast reading, since the response can be obtained in less than two hours from irradiation; and (c) dosimetric advantages owing to the lack of fading and insensitivity to β or γ radiations. The method adopted and the equipment used to set up the dosimeter are described. Results are reported and briefly discussed. (auth)

57857 DEVELOPMENT OF NEW NEUTRON DETECTORS FOR ACCIDENT DOSIMETRY. Piesch, E. (Kernforschungszentrum, Karlsruhe, Ger.). pp 399-424 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

New detectors and measuring techniques are proposed to improve the assessment of individual doses in a criticality accident. The aim was to reduce the number of detectors in the conventional detector combinations, to use sensitive activation reactions and to measure the dose of intermediate and fast neutrons directly. The proposed neutron detectors for the dosimeter combination are: (a) Arsenic, to detect slow and intermediate neutrons up to 1 MeV by the $^{75}As(n,\gamma)^{76}As$ reaction (half-life of ^{76}As is 26.4 h); (b) Phosphorus, to detect fast neutrons above a threshold of 2 MeV by the $^{31}P(n,p)^{31}Si$ reaction (half-life of ^{31}Si is 2.6 h), and slow neutrons by the $^{31}P(n,\gamma)^{32}P$ reaction (half-life of ^{32}P is 14 d); (d) A polycarbonate detector (Makrofol E) as a nuclear track detector to detect fast neutrons above a threshold of 0.5 MeV by elastic scattering and (n,α) reactions in carbon and oxygen. The β-activity of ^{76}As, ^{31}Si and ^{32}P can be measured directly in As_2S_3 glass and in phosphate glass by means of the β-induced Cherenkov effect. It uses a liquid scintillation counter set up as for tritium measurements. The calibration of the detectors was performed by calculations of the detector sensitivity for different neutron spectra and by irradiation with different neutron sources at different criticality installations. After an accident a first estimation of the neutron dose is obtained by a β-counting of the arsenic phosphate glass, which indicates the surface adsorbed dose or the total neutron fluence directly. It is energy independent over the range of intermediate and fast neutrons. (auth)

57858 CALCULATIONS OF DOSE FRACTIONS OF SLOW, INTERMEDIATE, AND FAST NEUTRONS BEHIND DIFFERENT SHIELDS, AS WELL AS READINGS OF SELECTED DOSIMETERS. Makra, S.; Bekes, E. (Central Research Inst. for Physics, Budapest). pp 425-33 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The percentage doses of slow, intermediate and fast neutrons were determined for a fission source shielded by materials of different composition and thicknesses. Water, polythene, iron, concrete, concrete + iron, and concrete + boron materials, and thicknesses ranging from 5 cm to 200 cm were considered. Making use of these results one can estimate the percentage dose measured by, and the correction factors to be applied for different dosimeters. A more sophisticated method of evaluating the reading is to multiply the response function by the spectra values and to integrate over the energy range in question. Based upon these calculations, readings are presented for several dosimeters and results are compared. Results show the great importance of intermediate energy neutrons. (auth)

57859 ENERGY CALIBRATION OF DOSIMETERS FOR GAMMA AND X-RAYS. Drexler, G.; Gossrau, M. (Institut fuer Strahlenschutz, Neuherberg, Ger.). pp 477-84 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The evaluation of energy dependence of health physics instrumentation, especially for low-energy radiation, is of great interest. If the exact knowledge of the response of an instrument as a function of photon energy is needed, sources of monoenergetic radiation are required. Since, in the energy range considered, a suitable set of nuclides is not available and beams of fluorescence X-rays, limited in energy to about 100 keV, are difficult to realize in practice at a sufficient dose rate, the only method is to modify the heterogeneous output of an X-ray machine by filtration. The result of a calibration of an instrument strongly depends on the spectral distribution of the beam, and this makes it necessary to use well-defined radiation for this purpose. Defining an "effective energy" (E_{eff}) is not sufficient to characterize the beam. This led to the establishment, for the energy range 40 to 300 keV, of a set of nine radiation qualities, which have the advantage of being reproducible and having a similar spectral dose distribution, making detailed description of the properties of the calibration beam possible. To illustrate the influence of the spectral distribution, the response of several instruments has been compared for radiations having the same mean energy. From the results it can be seen that only a knowledge of the photon spectra gives enough information to interpret the deviations in the various response functions. (auth)

57860 MAINTENANCE OF ELECTRON EQUILIBRIUM IN THE CALIBRATION OF DOSIMETERS IN GAMMA RADIATION BEAMS. Kostyleva, Yu. G.; Mysev, I. P. (All-Union Research Inst. for Instrument Making, Moscow). pp 485-94 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The effect of calibrating the gamma radiation of a source on the maintenance of electron equilibrium and observance of the inverse-square law in the calibration of dosimeters is considered. The expression for an absorbed dose in air on the beam axis, its difference from an exposure dose and the detector readings are investigated as a function of various factors: measurement geometry (distance from source, beam diameter), photon energy and detector-wall thickness. It is shown that for a given geometry this difference and the non-observance of the inverse-square law can lead to considerable errors in the calibration of a detector, and the conditions under which such errors can be neglected are determined. A relationship between the readings of normal chambers and the exposure dose was found. The non-uniformity in the distribution of an absorbed dose in air and the effect of this non-uniformity on errors in the calibration of dosimeters are considered as a function of the above-mentioned factors. The agreement between the calculated and experimental data is discussed. (auth)

57861 DOSIMETRIC CHARACTERISTICS OF A TEFLON-CARBON MIXTURE FOR THE CONSTRUCTION OF CAVITY CHAMBERS FOR MEASUREMENT OF ABSORBED DOSE IN THE AIR. Simoen, J. P.; Sklavenitis, L.; Troesch, G.; Pages, L. (CEA, Saclay, France). pp 567-78 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The theoretical calculation of the dose absorbed in air, based on dose measurements in a cavity within a given material, provides a means of determining the required correction factor and the conditions under which one material will be equivalent to another from the dosimetric point of view. A comparison of the materials currently in use for the construction of ionization chambers, such as graphite, nylon, etc. with Teflon-carbon, shows the latter to be an excellent air-equivalent material and demonstrates its value for the construction of cavity-type ionization chambers. (auth)

57862 DOSIMETRY OF X-RAYS, GAMMA-RAYS, AND NEUTRONS WITH A FERROUS SULFATE SOLUTION. Antoku, Shigetoshi; Sunayashiki, Tadashi (Hiroshima Univ.). Hiroshima Daigaku Genbaku Hoshano Igaku Kenkyusho Nenpo; No. 10, 27-31(May 1969). (In Japanese).

Radiation doses from x-rays (180 kVp, HVL: 1.18 mmCu), γ-rays (Co-60) and neutrons (T, d reaction, 14 MeV) were measured using a ferrous sulfate dosimeter (Fricke dosimeter) and results were compared with earlier ones. The chemical yield per unit absorbed energy (G-value) used were 15.2 for x-rays and 15.6 for γ-rays. Neutron doses were calculated for the two G-values—10.5 and 11.5 for 14 MeV neutrons—which have appeared in the literature. Present dose measurements for Co-60 γ-rays were 2.7 percent higher than those by a ferrous sulfate dosimeter in 1963 calculated using 5.263 years as a half-life of Co-60. One-third of this difference resulted from the different rad conversion factors according to ICRU Tables. Errors in half life and chemical determinations account for the remaining two-thirds of the discrepancy. X-ray dose was previously monitored mainly with an integrator of the Radocon dosimeter, probe #601. Results with chemical dosimeter in this study were 6.0 percent lower than those obtained with the Radocon. Neutron doses have been monitored with a plastic scintillator and by the activation method of the $^{32}S(n,p)^{32}P$ reaction. There is a ten percent difference between the two reported G-values and there are no reasonable data by which this can be corrected. Therefore no conclusions could be made concerning the ferrous sulfate dosimeter. The G-value of the dosimeter for 14 MeV neutrons was calculated to be 10.4, based on the scintillation method and 10.8 according to the activation method. Dose readings of the ferrous sulfate dosimeter in this study agreed with those of the standard dosimeter used for the intercomparison of Co-60 γ-rays in Japan. (auth) (Japan)

Radiometric Instruments

Refer also to abstract 59632.

57863 (CONF-711002-, pp 307-20) TARGET THICKNESS AND UNIFORMITY MEASUREMENTS USING CHARGED PARTICLES. Adair, H. L. (Oak Ridge National Lab., Tenn.). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

The use of alpha particles and fission fragments for measuring target thickness and uniformity of samples varying in areal density from a few $\mu g/cm^2$ to several mg/cm^2 is discussed. Since the accuracy of this technique is limited by the accuracy of the stopping power data, stopping power data for several materials have been determined which should increase the accuracy for these materials to ±7% or better. Beta particle absorption techniques have been applied to target uniformity measurements for those samples whose thicknesses exceed the range of the alpha particles and fission fragments. (W.H.K.)

57864 (INS-TL-112) ALPHA-RAY THICKNESS GAUGE. 2. Nonaka, Itaru; Sugai, Isao (Tokyo Univ. (Japan). Inst. for Nuclear

XUM

Study). 8 Jul 1971. 11p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The α-ray thickness gage described in INS-TL-110, (1970) was improved. A new ^{241}Am source of 1.03 μCi was prepared instead of the old one of 0.1 μCi. The effective strength of the α-rays was improved as high as about 20 times that of the old one, and the accuracies of measurements were much improved. A counting rate meter was tested to be used in this α-ray thickness gauge. It was very effective in locating the positions of the ends of the residual ranges. The corrections for the differences of the temperatures between the measurements of samples and of air are discussed. (auth) (Japan)

57865 (NP-18941) MEASUREMENT OF THICKNESSES OF VARIOUS MATERIALS USING Si(Li) AND SURFACE BARRIER DETECTORS. Perez Medina Ollivary, Victor (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1971. 82p. (In Spanish). Dep. NTIS (U. S. Sales Only). Thesis.

The various types of devices used in the measurement of thickness and uniformity are described. The nuclear detector types and their properties are then discussed. Surface-barrier semiconductor and Si(Li) detectors are emphasized. The results obtainable with each type are discussed. The experimental methods used in testing the characteristics of surface barrier and Si(Li) detectors as thickness measuring devices are described. A device for automatically obtaining these measurements and using transistors is discussed. Results obtained for mylar and Al foils are reported. (J.S.R.)

57866 (SC-RR-710450) DETECTION OF HIGH EXPLOSIVES BY CAPTURE GAMMA-RAY TECHNIQUES. Powell, J. E.; Matthews, J. W. (Sandia Labs., Albuquerque, N. Mex.). Aug 1971. 56p. Dep. NTIS.

A series of steady-state experiments was carried out to study the feasibility of using the ^{14}N(n,γ)^{15}N reaction for the detection of land mines. Background effects from inelastic gamma rays were studied by using 14 MeV and fission neutron sources. Other aspects of the technique such as detector response to high energy gamma rays, energy spectra of capture gamma rays from soil and high explosive (HE) samples, and signal-to-background (from capture gamma rays emitted from the soil) ratios were also studied. The experiments showed that because of inelastic gamma rays and fast neutron backgrounds a pulsed source and fast timing procedures were required for a practical mine detector. Because of the pulse pile-up problem, a segmented high Z loaded organic scintillator seems to be the only practical detector. (auth)

57867 NEW RADIOMETRIC APPARATUS FOR PROSPECTING RADIOACTIVE ORES. Ovchinnikov, A. K.; Khromov, Yu. V.; Fomin, A. V. Razved. Okhr. Nedr; No. 9, 36-9(Sep 1970). (In Russian).

Three new types of radiometric apparatus are described which are intended for exploration and prospecting for radioactive ores. "Zond-1" may be employed for gamma logging at depths to 1,000 m and a diameter of 36 mm and larger. "Radon" uses a field scintillation emanometer and measures the concentration of radon and thorium in samples of surface air and water samples. The portable scintillation radiometer "SRP-68" is designed for measurements on the surfaces of shot holes and fine crevices. (tr-INIS)

57868 RADIO-ISOTOPE INSTRUMENTATION. Taylor, Denis (Univ. of Strathclyde, Glasgow). IEE (Inst. Elec. Eng.) Rev.; 118: No. 9R, 1090-1106(Sep 1971).

The use, design and performance of the various forms of radioisotope instrumentation are reviewed, with some comment on the historical development of the subject, and possible developments, in the future. Radio-isotope instrumentation comprises a radioisotope source and some measuring component, as used for investigational work in science and engineering, but more particularly in industry to improve both productivity and the quality of the product being manufactured. Emphasis is given throughout to the special techniques involved, and attention is also given, where possible, to applications in electrical engineering. An attempt is made to classify the various applications discussed and to give examples of each class. (auth)

57869 INVESTIGATING THE VIBROCOMPACTING OF CONCRETE MIXES WITH THE USE OF RADIOISOTOPES. Lishanskii, B. A.; Osmachkin, B. P.; Mikhailov, N. V. Beton Zhelezobeton; 16: No. 12, 16-17(1970). (In Russian).

A method was developed for investigating the kinetics of compaction of concrete mixtures and their density changes during vibrocompaction. The vibrocompaction process may be considered complete as judged by the stabilization of movement of a labelled grain in a concrete casting. Block diagrams of the radioisotope-measuring equipment are furnished and discussed. (K.S.W.)

57870 METHOD FOR DETERMINING THE MASS OF DUST DEPOSITED ON MEMBRANE FILTERS BY MEASUREMENTS OF THE ABSORPTION OF BETA RAYS. Liniecki, Julian; Wiecek, Edward; Domanski, Tomislaw. Med. Pracy; 21: No. 6, 608-14(1970). (In Polish).

A simple method was developed for determination of the mass of dust deposited on membrane filters by means of measurements of the absorption of ^{14}C beta-rays (E_{max} = 155 keV). The precision of the method (per cent standard error) is ±9.2% and sensitivity can be expressed as 0.12 mg per cm^2 of the membrane filter. Other filters of similar thickness and filtering ability may also be used. Practical usefulness of the method is emphasized. (auth)

57871 DEVICE AND METHOD USING GAMMA RAYS FOR SIZE AND DENSITY PRODUCE SELECTION. Garrett, Roger E.; Talley, Wilson K. (to Univ. of California). U. S. Patent 3,594,579. 20 Jul 1971. Filed 6 Jun 1968.

A radiometric produce selector for harvesting produce moves a radiation source (viz. gamma rays) relative to the produce with a collimated pencil of radiation traveling through the produce to a receiver on the other side of the produce. The response of the receiver is a direct signal. This may be integrated to provide an indirect signal. These signals are used individually or together to afford a final response. A response exceeding a threshold value can be used to actuate a harvester. The method of selecting produce involves sending a signal through the produce, the signal being attenuated in accordance with the density and size (viz. thickness), and determining the value of the attenuated signal. The system is designed for head lettuce and similar produce. (auth)

57872 APPARATUS FOR DETERMINING THE DENSITY OF PULVERALENT MATERIALS IN RESERVOIR BY MEANS OF A RADIOACTIVE SOURCE AND DETECTOR. Figuet, Maurice G.; Rottner, Gerard; Michaud, Andre Louis (to Fabriques de Produits Chimiques de Thann et de Mulhouse). U. S. Patent 3,582,647. 1 Jun 1971. Filed 27 Aug 1969.

An apparatus and process is described for checking the flow of pulverulent materials contained in a reservoir, which consists of measuring the absorption of an electromagnetic radiation of suitable frequency by the mass of material situated in the reservoir at the level of measurement. (auth)

57873 IONIZATION FIRE DETECTION DEVICE. Ponsar, Christian Marie Maurice Bertrand (to Vigifeu). U. S. Patent 3,582,646. 1 Jun 1971. Priority date 6 Feb 1967, France.

A fire detection device comprising an enclosure enclosing a reference ionization chamber and an unsaturated measuring ionization chamber interconnected in series and each containing a source of radioactive radiations, at least one alarm and/or automatic intervention device, a grid permeable to gases defining one end of the enclosure, the enclosure having apertures communicating with passages at one end of the unsaturated chamber so that gas can flow through the unsaturated chamber, from outside the device, a common electrode extending into both chambers and a printed circuit controlling the alarm and/or intervention device is described. (auth)

57874 CHOICE OF SOURCE ENERGY AND ACTIVITY FOR A RADIOMETRIC METHOD OF ISOTOPE NONDESTRUCTIVE TESTING. Pokrovskii, A. V.; Ripp, A. G. (Tomsk Polytechnic Inst., USSR). Defektoskopiya; No. 2, 108-11(1971). (In Russian).

Current methods of selecting gamma-radiation sources for defectoscopy were examined, and some of their deficiencies were demonstrated. It was shown that the choice of the source energy is directly determined by its activity. Some quantitative results are presented in connection with the selection of source energy and activity for control of steel products of various thickness by means of a radiometric method. (tr-auth)

Miscellaneous Instruments and Components

Refer also to abstracts 57481, 57571, 57628, 57646, 57722, 57792, 59772, 59835, 60058, 60089, 60090, and 60181–60184.

57875 (INR-1319) INTERCOMPARISON MEASUREMENTS OF THE SKODA AND INR CALORIMETERS ON THE EWA-10 REACTOR. Kott, J.; Jirousek, V.; Teren, S.; Labrousse, M.; Ondricka, K.; Stefanik, J.; Labno, Leszek; Janikowski, Andrzej;

Lopuszynski, Jerzy; Byszewski, Witold; Kot, Janusz (Institute of Nuclear Research, Warsaw (Poland)). 1971. 19p. Dep. NTIS (U. S. Sales Only).

The aim of this experiment was to compare the properties of the SKODA-type calorimeters and the calorimeter constructed in the Neutron Detectors Laboratory of Reactor Physics Department of the INR specially for application in low-intensity reactor radiation fields. The measurements were performed on the EWA-10 reactor at Swierk. A good agreement between the measurement results was obtained using both types of calorimeters, and their applicability for measurements in zero-power reactors was confirmed. (auth)

57876 NEW HIGH-STABILITY NICKEL ALLOY THERMOCOUPLE. Northover, E. W.; Hitchcock, J. A. (Central Electricity Research Labs., Leatherhead, Eng.). Instrum. Pract.; 25: No. 9, 529-31(Sep 1971).

A thermocouple is proposed comprising a positive limb of 87:13 nickel-chromium alloy and a negative limb of 97:3 nickel-silicon alloy which will have a stability comparable with the noble thermocouples (such as Pt. Rh/Pt.) combined with the high sensitivity of the conventional Ni.Cr/Ni.Al thermocouples. Its temperature limit is expected to be similar to that of Ni.Cr/Ni.Al, i.e. ~ 1200°C and it should be suitable for use in reactor environments (cf. Pt.Rh/Pt.). An e.m.f./temperature calibration for the new thermocouple is given. (auth)

57877 CHARACTERIZATION OF A DIFFUSION TUBE HYDROGEN DETECTOR IN A DYNAMIC SODIUM SYSTEM. Roy, Prodyot; Rodgers, Douglas N. (General Electric Co., Sunnyvale, Calif.). Nucl. Technol.; 12: No. 4, 388-92(Dec 1971).

Monitoring of hydrogen in liquid sodium with a diffusion tube type hydrogen detector has recently become of interest in the liquid metal fast breeder reactor (LMFBR) development program. The present investigation was undertaken to characterize a diffusion type detector and to study sodium-hydrogen chemistry with the aid of the detector and gas chromatography. The study was carried out in a cold trapped, pumped sodium loop. It was observed that the activity of hydrogen in sodium and in the cover gas is controlled by the temperature of the cold trap. This study also showed that at lower concentrations of hydrogen (~<2 ppM), the activity of hydrogen in sodium decreases with increasing temperature, which is believed to be due to the interaction between oxygen and hydrogen. However, at higher hydrogen concentrations (~>2 ppM), the activity of hydrogen is independent of temperature. Finally, it was observed that the permeation of hydrogen dissolved in sodium through a stainless steel membrane is a diffusion controlled process. (auth)

57878 POSSIBILITY OF VARIATIONS IN UNIT PULSES OF RADIATIVE HEAT. Ogorodnik, S. S.; Tsoglin, Yu. L. This paper was summarized in At. Energ. (USSR); 29: No. 5, 362-3(Nov 1970) as paper No. 438/5634. (In Russian).

Full copy of this paper is held by DTIE.

The design and operation of a thermodiverger for measuring pulsed quantities of heat are described. Calibration data for a thermodiverger for measuring the heat generated by radiation in the structural materials of a nuclear reactor operating with unit pulses 50 sec long are presented. (W.H.K.)

57879 INVESTIGATION OF THE CALIBRATION CHARACTERISTICS OF A RADIATION THERMODIVERTER IN HIGH-INTENSITY FIELDS OF IONIZING RADIATIONS. Karasev, V. S.; Ogorodnik, S. S.; Tsoglin, Yu. I. This paper was summarized in At. Energ. (USSR); 29: No. 6, 449(Dec 1970) as paper No. 447/5834. (In Russian).

Full copy of this paper is held by DTIE.

An integrated heat flux calorimeter, known as a radiation thermodiverter (RTD), is proposed for measuring heat generated by radiation. This device features high accuracy, high sensitivity, quick response, and arbitrary shape and size. The behavior of the calibration curves of the RTD in response to irradiation was studied experimentally and the results of long-term radiation stability tests directly in the core of the nuclear reactor are reported. (W.H.K.)

57880 CAMAC DATAWAY AND BRANCH HIGHWAY SIGNAL STANDARDS. Larsen, R. S. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 26-32(Apr 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The basic dataway operation is briefly described to illustrate the use of various control lines. Voltage, current, and timing characteristics of CAMAC Dataway and Branch Highway signals are given. (R.W.R.)

57881 SHORT DESCRIPTION OF THE CAMAC BRANCH HIGHWAY. Kirsten, Frederick A. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 19-25(Apr 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A short summary and description of the CAMAC Branch Highway are presented. The purpose of the Branch and some of its characteristics are explained. Certain operational sequences are described in detail. (auth)

57882 OPERATIONAL CHARACTERISTICS OF THE CAMAC DATAWAY. Kirsten, Frederick A. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 9-18(Apr 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The basic purpose of CAMAC is to provide a standardized method for transmitting data and control information between instrumentation modules and a digital controller. CAMAC encompasses both a hardware standard for housing the modular components of a system and an electrical and logical standard for the control "language" used in the transfer of digital information. The CAMAC specification contains the rules for both of these aspects of CAMAC. The features and uses of the control language are described in a less formal way than that used in the specification. Examples are given of the interplay of control and synchronization signals between the modules concerned. This paper is designed to supplement the CAMAC specification. (R.W.R.)

57883 CAMAC INSTRUMENTATION SYSTEM: INTRODUCTION AND GENERAL DESCRIPTION. Costrell, Louis (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 3-8(Apr 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The CAMAC instrumentation system, developed by the ESONE Committee of European laboratories, has been endorsed by the U. S. AEC NIM Committee as a dataway system complementary to the NIM (Nuclear Instrument Module) system. CAMAC is described in a general way. (auth)

57884 COMPUTER CONTROLLED CAMAC SYSTEMS AT ARGONNE. Strauss, M. G.; Lenkszus, F. R.; Brenner, R.; (and others) (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 46-52(Apr 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Several computer-controlled CAMAC systems are presently being developed at Argonne for data acquisition in low-energy nuclear physics. Four of these are discussed. The systems are designed around 8K, 16-bit, Lockheed MAC-16 computers. A typical system includes two CAMAC crates and a complement of 15 modules. The crate controller in each crate serves as interface between the computer I/O bus and the CAMAC dataway. Up to 14 individual crates can be addressed in addition to a Teletype and other peripheral devices. The CAMAC modules being developed include Crate Controller, Dual ADC Controller, ADC Coincidence Unit, Dual Stabilizer, Quad Pre-Scaler, Clock, Display Controller, Readout Selector, Magnetic Tape Controller, and Disk Controller. Most units are built in double-width modules using computer-controlled wire-wrap construction. (auth)

57885 SOME CHARACTERISTICS OF INTERFACES BETWEEN CAMAC AND SMALL COMPUTERS. Kirsten, Frederick A. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 39-45 (Apr 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The typical CAMAC system has a small computer attached to it. In the usual case, the computer acts as a repository for data generated by CAMAC, and also controls and directs the CAMAC operations. Some of the aspects of the hardware interface, as well as some of the interaction between the computer and the CAMAC system, are discussed. (auth)

57886 PROPOSAL OF A UNIQUE NOMENCLATURE FOR VOLTAGE COMPARING ADC's. Drosg, M. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 117(Apr 1971).

A simple scheme is given from which names for the five basic voltage-comparing ADC's can be obtained uniquely. (auth)

57887 USE OF AN ON-LINE DIGITAL COMPUTER FOR ENHANCEMENT AND INTEGRATION OF NUCLEAR RESONANCE

XUM

SPECTRA. Waymark, R. D. B.; Bowman, D. R. (University Coll., London). Radio Electron. Eng.; 41: No. 8, 421-9(Sep 1971).

The design and practical considerations involved in coupling a small digital computer to work on-line with a chemical research n.m.r. spectrometer are described. The various requirements of spectrometer, computer, interfacing and programming are dealt with both in general terms and in relation to the specific system employed in the described project. The effectiveness of the practical system is assessed, and some typical results are included. (auth)

57888 SUMMARY OF CAMAC: STATUS AND OUTLOOK. Mack, Dick A. (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 69-70 (Apr 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The status of CAMAC is reported, along with its relation to the NIM system. Up-to-date specifications for CAMAC power supplies are given. (R.W.R.)

57889 TWO-CHANNEL DEFECTOSCOPE. Nedavnii, O. I. (to Nautchno Issledovatelskii Institut. Tomskom Politekhnitcheskom Institut). Russian Patent 270,320. 8 May 1970. Filed 14 Jun 1965. (In Russian).

A defectoscope with two channels and a radiation source is described. Diagrams of this device are also included. (J.F.P.)

57890 60^0 SECTOR MASS SPECTROMETER FOR GAS ANALYSIS. Prahallada Rao, B. S.; Murthy, M. S.; Rama Rao, V. V. K. (Bhabha Atomic Research Centre, Bombay). Indian J. Technol.; 9: No. 2, 47-50(Feb 1971).

A mass spectrometer of 10 cm radius and 60° magnetic sector field has been designed for gas analysis work. A new, bakeable, all-stainless steel valve is used in the sample handling system. A resolution of around 80 and a sensitivity of 10^{-10} torr for the partial pressure of nitrogen were obtained. The degree of resolution obtained with the instrument is adequate for routine analysis of gases and gas mixtures. (auth)

57891 CALCULATION, CONSTRUCTION, AND TESTING OF COLLIMATORS USED FOR SCINTIGRAPHY WITH LOW-ENERGY RADIONUCLIDES. Zeidler, U.; Geisler, S. (Institut fuer Nuklearmedizin und Spezielle Biophysik, Hanover). Nucl.-Med.; 10: No. 2, 167-95(15 Jul 1971). (In German).

A simplified method is described of calculating and constructing collimators for use in scanning with low-energy radionuclides. The construction of three out of eight collimators built using this method is described in detail. These collimators — a 217-hole collimator with medium resolution, a 490-hole long-focus and a 856-hole fine-focus collimator — were tested by means of line-spread functions. The results showed good correlation with the calculations. (auth)

57892 METHOD FOR THE DESIGN OF NEAR-OPTIMUM FILTERS FOR NUCLEAR SIGNAL TRANSMISSION SYSTEMS. Battista, A. J. (Lockheed Palo Alto Research Lab., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 142-7(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A novel approach for designing near-optimum filters for coaxial transmission lines carrying nuclear signals is presented. The method involves a non-linear least-squares fitting of the filter parameters to best-fit the desired ideal response. Unlike previous empirical methods to match the amplitude response of the cable, the fitting is done to both amplitude and phase responses. The algorithm used in order to determine the best set of filter parameters is one that combines the best features of the gradient search method on the hyper-surface formed by the parameters with the analytical solution of the fitting function; this combination provides fast convergence. After the set of filter parameters that give the best fit to the ideal response is determined, the actual filter is designed. A computer program developed to do the fitting and design and to display the results in both tabular and graphical forms. (auth)

57893 DESIGN AND CONSTRUCTION OF A FOUR-DECADE DIGITAL LOG RATEMETER. Thorington, John M. Jr. (Auburn Univ., Ala.); Andrews, Vernon E. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 148-54(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A four-decade digital log ratemeter using integrated circuits for all active components was designed and tested. The ratemeter is capable of measuring pulse rates ranging from 1.11×10^{-1} to 2.0×10^7 pulses per second. With a very simple modification the ratemeter can be made to have any desired number of decades in its output. The input pulse rate is determined by digital counting circuits; and the logarithm of the pulse rate is approximated by seven digital functions, which are generated by a series of combinational logic networks. The output is available in either digital or analog form. The system is composed of the following sections: timing and control, counting, transfer, round-off, log converter, storage, and digital-to-analog converter. Experimental results showed that the digital log ratemeter has, for the same statistical accuracy, a much faster response time than conventional log ratemeters. It was shown also that the digital log ratemeter is capable of being used to measure much lower pulse rates than is practicable with conventional log ratemeters. (auth)

57894 MOSFET CURRENT-TO-FREQUENCY CONVERTER WITH A LINEAR SUB PICOAMPERE-TO-MICROAMPERE RANGE. Shapiro, Edward G. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 155-9(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A current-to-frequency converter with a single linear current range of 10^{-13} to 10^{-6} amperes was developed for monitoring ion chamber currents. The converter has an output transfer function of 10^{-11} amperes/Hz or 10^{-11} coulombs/count that is temperature compensated. Its frequency output, which is compatible with most scalers, yields a maximum linear rate of 10^5 Hz at 10^{-6} amperes input current. (auth)

57895 DELAY TIME STUDIES IN A CHANNEL ELECTRON MULTIPLIER. Briscoe, William L. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 222-3(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Delay time and gain for a Bendix 4028 Channeltron was studied during accelerated life tests. The results are presented along with a suggestion for delay compensation. Novel means for synchronous stimulation of the multiplier and for measurement of the output charge are presented. (auth)

57896 PROGRAMMABLE SOLID STATE PULSER FOR CHARGE-SENSITIVE AMPLIFIER SYSTEMS. Burtis, D. W. (Time-Zero Corp., Torrance, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 282-6(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A circuit was developed which allows excitation of charge-sensitive amplifiers at high pulse repetition rates. The amplifier output waveform fidelity is nearly as good as that associated with low-repetition-rate mercury-relay pulsers. The circuit may be self-contained or operated under external control by supplying a reference voltage and clock signals to initiate pulses. The elements of the pulser are discussed in detail, and some applications are suggested. The circuit was tested for amplitude stability as a function of temperature and pulse repetition rate. (auth)

57897 COMPUTER CONTROLLED INSTRUMENTATION FOR PLUTONIUM MEASUREMENT. Lawless, J. L.; Anna, T. L. (Dow Chemical Co., Golden, Colo.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 327-31(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A small digital computer was successfully interfaced to nuclear counting systems in a plutonium recovery facility. The counting systems are used to measure plutonium content of waste and process residues. The computer initializes the counting sequence, accepts the data, computes the plutonium content, and prints the documented information. (auth)

57898 NUCLEAR REACTOR APPLICATIONS OF NEW ULTRASONIC TRANSDUCERS. Lynnworth, L. C. (Panametrics, Waltham, Mass.); Papadakis, E. P.; Patch, D. R.; Fowler, K. A.; Shepard, R. L. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 351-62(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

New high-temperature and broadband magnetostrictive and piezoelectric ultrasonic transducers have been developed for testing, measurement, and control. Potential reactor applications include measuring fuel centerline temperature, sodium temperature profile (ten points with only one wire), occurrence and location of bubbles in liquid coolants, liquid level, flow, gas pressure, nondestructive testing, and acoustic emission surveillance. (auth)

57899 AUTOMATIC-RANGING PICOAMMETER FOR REACTOR CONTROL AND PROTECTION. Ball, R. M.; Lovallo, J. M. (Babcock and Wilcox Co., Lynchburg, Va.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 435-7 (Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

An automatic-ranging picoammeter covering full-scale ranges from 3×10^{-11} to 1×10^{-3} amperes with a 50% over-range capability has been designed, built, tested, and installed for use with Babcock & Wilcox's Lynchburg Pool Reactor. The unit incorporates three major improvements over previous instrumentation and commercially available equipment: elimination of manual range changing, provision for adjustable power level trips throughout the operating range of the reactor, and provision for a trip function upon detection of a period shorter than that preset into the instrument. (auth)

57900 CONTINUOUS CONCENTRATION DEVICE FOR RADIOACTIVE WASTE WATER. (to Licentia Patent-Verwaltungs GmbH). French Patent 2,000,999. 19 Sep 1969. Priority date 30 Jan 1968, Germany. (In French).

An apparatus is described for the continuous concentration of radioactive waste water in a vessel serving likewise for longtime storage in which the waste water is heated without stirring. The heat source is arranged in the interior of the vessel and heats the surface of the water without bringing it to the boiling point. A gas entering through an orifice is used to sweep the evaporated liquid from the vessel, and a heating device, arranged laterally at the bottom of the vessel on the outside, produces a circulation of the concentrate. (E.J.H.)

57901 DOUBLE-FOCUSING QUADRUPOLE LENS SPECTROMETER AND ITS USE IN THE STUDY OF VARIOUS NUCLEAR REACTIONS. Green, Ray E. L. Boulder, Colo.; Univ. of Colorado (1970). 145p. University Microfilms Order No. 71-21,590.

Thesis.

Various methods of using the chromatic aberration inherent in magnetic quadrupole lenses as the basis for constructing low-resolution spectrometers and magnetic rigidity band-pass filters that require the use of only one relatively small detector are studied. The thick-lens approximation for the behavior of quadrupole lenses is used; corrections to this approximation because of imperfections in magnetic lenses are discussed. The various methods of utilizing a quadrupole doublet to construct such a system are discussed extensively, and systems based on a quadrupole triplet are considered briefly. An operational system utilizing a quadrupole doublet is described, and data from representative experiments for which the system has been used are presented to demonstrate the potential that such systems possess. The ^{46}Ti(^{3}He,t)^{46}V reaction for an incident ^{3}He beam energy of 37.7 MeV is discussed in detail. Data taken between scattering angles of 5 and 25 degrees with the double-focusing quadrupole-lens spectrometer developed and other data available between 17.5 and 45 degrees are used with the distorted-wave Born approximation (in which the interaction potential used includes a tensor force term) to determine tentative spin assignments for five states in ^{46}V and to restrict the spin assignments for eleven other states to two or three possibilities. (Diss. Abstr. Int., B)

57902 RECENT ADVANCES IN GAS-DISCHARGE DUPLEXERS. Paik, S. F.; Jellison, F. A. (Microwave Associates Inc., Burlington, Mass.). pp 201-6 of Gas Discharges. London; Institution of Electrical Engineers (1970).

From International conference on gas discharges; London, England (15 Sep 1970). See CONF-700969.

The use of radioactive primers in microwave gas discharge switches is discussed, as representing an improvement in reliability. The most promising of these are T and ^{63}Ni, the former being used as a metal tritide, such as Ti tritide. The advantages and disadvantages of each are stated. Experiments to test the effectiveness of radioactive primers are indicated. Overall, T is to be preferred. (UK)

Radiation Effects on Instruments and Instrument Components

Refer also to abstract 57746.

57903 CHANGES OF NONLINEAR PARAMETERS OF SEMICONDUCTOR RESISTORS (VARISTORS) OF BLACK SILICON CARBIDE AS A RESULT OF GAMMA IRRADIATION. Kashukeev, N.; Ribarov, S.; Krezhov, K. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 24: No. 4, 435-8(1971). (In Russian).

Black silicon carbide semiconductor resistors (varistors) were exposed to gamma radiation at 10R/sec from a ^{60}Co source and then tested on a modified Wheatstone bridge for resistance changes. The data obtained showed that both static and differential resistances were altered similarly: with increased gamma dose the resistance fell to a minimum, and then increased, the minimum occurring at about 0.8×10^{6} R. Two possible competing processes which may explain this phenomenon are discussed. (K.S.W.)

57904 MODIFICATION OF THE TRAC EBERS–MOLL MODEL FOR IMPROVED HIGH FREQUENCY AND COLLECTOR STORAGE TIME PREDICTIONS. Maldonado, C. D.; Kleiner, C. T. (Autonetics, Anaheim, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 71-83(Apr 1971). (CONF-700713–2). Fro

From Conference on nuclear and space radiation effects; San Diego, Calif. (21 Jul 1970).

The TRAC Ebers-Moll model is modified in order to obtain an improved high frequency prediction. This is achieved by means of a three lump Linvill model to account for diffusion transport of minority carriers in the base region of a bipolar transistor. The modified Ebers-Moll model obtained in this manner yields two pole representations for the transport factors in the frequency domain. The two pole representation for h_{fe} is shown to give reasonable fit both in amplitude and phase with experimental data obtained from a low frequency bipolar transistor, while the phase correlation obtained with the single pole representation of the present TRAC Ebers-Moll model is unsatisfactory, especially at high frequencies. The present TRAC Ebers-Moll model was also modified so as to obtain an improvement in collector storage and recovery time prediction. This was accomplished by the introduction of two Linvill lumps in the collector region to account for minority carrier storage and transport. The observed experimental collector-base diode turn-off transient response for the same low frequency bipolar transistor was found to be in agreement with the prediction of the modified model. Also, a discussion of a modified model to account for both the high frequency response, as well as collector storage and recovery time effects is presented. (auth)

57905 IMPROVED FAST NEUTRON TOLERANCE OF GaAs JFET's OPERATING IN THE HOT ELECTRON RANGE. McNichols, J. L.; Zuleeg, R. (McDonnell Douglas Astronautics Co., Santa Monica, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 111-13(Apr 1971).

The fast-neutron-induced degradation of the electrical characteristics of n-channel GaAs junction field-effect transistors (JFET's) operating in the Shockley mode (thermal equilibrium) has been estimated previously. Advances in technology have led to the fabrication of devices and micron-sized channel lengths, which are capable of response at microwave frequencies. Short channel lengths, however, result in device operation under thermal nonequilibrium conditions, and hot electron effects must be considered. The theory of Lehovec and Zuleeg [Solid-State Electron., 13: 1415(1970)], which provides the characteristics for JFET's operating in the hot electron range, is employed to estimate the neutron degradation of these devices. It is shown that JFET's operating in the hot electron range are more resistant to neutron exposure than are JFET's operating in the Shockley region. Devices with channel-doping concentration of 10^{17} cm^{-3} are predicted to survive fluences of 10^{16} neutrons/cm^{2}. Some preliminary test results are reported. (auth)

57906 PERMANENT RADIATION EFFECTS IN SWEPT AND UNSWEPT OPTICAL GRADE SYNTHETIC QUARTZ AT RESONATORS. EerNisse, E. P. (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 86-90(Apr 1970).

Permanent changes in the frequency versus temperature characteristics of unswept and swept optical-grade synthetic-quartz AT resonators that are caused by fast-neutron and ^{60}Co irradiations were investigated. Neutron damage shifts the frequency versus temperature characteristics of the unswept resonators upwards in frequency across the entire zero to +120°C temperature range at a rate of 0.56×10^{-15} ppM per N/cm^{2}, which is the smallest value yet reported in the literature. The observed erratic results for swept resonators were attributed to effects of ionizing radiation accompanying the neutron fluence and led to the ^{60}Co investigation. The unswept optical-grade quartz was found to provide AT resonators that are more resistant to ionizing radiation than any other unswept material yet investigated in the literature. Appreciable amounts of acoustically active defects attributed to Na impurities, which were apparently added during sweeping, were indicated by the ^{60}Co results for the swept devices and made the swept devices useless as radiation-resistant resonators. (auth)

XUM

57907 ELECTRON RADIATION DAMAGE EFFECTS IN SILICON SURFACE-BARRIER DETECTORS. Liu, Y. M.; Coleman, J. A. (National Bureau of Standards, Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 192-9(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Silicon surface-barrier detectors were irradiated at room temperature with monoenergetic electrons in the energy range of 200 keV to 1 MeV. The changes of detector reverse leakage current, noise, capacitance, and alpha-particle counting response were determined. In general, detector current and noise increased with electron fluence and energy for electron energies of 400 keV and above. Detector capacitances tended to decrease slightly for electron fluences up to 10^{13} cm^{-2} and increase at higher fluences. No significant degradation of detector performance was observed as a result of irradiation with 200-keV electrons for fluences up to 10^{16} cm^{-2}. The effects of damage on detector performance were reduced when the rear, aluminum contact was irradiated rather than the front, gold contact. (auth)

57908 RADIATION HARDNESS OF A NEW MAGNETIC THIN-FILM RECORDING SYSTEM. Hsieh, E. J.; Winslow, J. W. (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 224-7(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Magnetic thin-film memory units of a new transient-recording system designed for nuclear data acquisition were tested for radiation hardness. The films were exposed to neutron and gamma doses on the order of 10^{12} n/cm^2 and 10^4 R, respectively. Analog signals stored in the films were photographed using a Suchow powder technique before and after the exposure. (auth)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Basic Processes

57909 RADIOIMMUNOASSAY FOR CANINE GROWTH HORMONE. Tsushima, Toshio; Irie, Minoru; Sakuma, Maki (Tokyo Univ.). Endocrinology; 89: No. 3, 685-93(Sep 1971).

A sensitive radioimmunoassay capable of detecting concentrations of growth hormone as low as 1 ng/ml of dog plasma was developed using the double antibody method. Antiserum to canine growth hormone (CGH) was prepared in guinea pigs, and it was found to be cross-reactive with porcine, rat, ovine or bovine growth hormone. The radioimmunoassay was applied to the determination of plasma GH levels on unanesthetized dogs under a variety of situations. Mean plasma GH levels after an overnight fast were 3.2 ± 0.5 in normal adult males and 4.3 ± 1.1 ng/ml in normal females. The values in newborn puppies were higher than in the adult dogs. Plasma GH levels in lactating or pregnant dogs were in the range for normal females. Suckling did not cause any detectable change of plasma GH in the lactating dogs on postpartum day 21–24. Exercise of 10 min running was also ineffective. Insulin hypoglycemia as well as a rapid fall of plasma glucose without hypoglycemia produced an increase of plasma CGH. The response to hypoglycemia was, however, quite sluggish in spite of a profound hypoglycemia. An infusion of arginine caused a prompt and marked rise of plasma CGH. Thus, it was found that the dog shares, at least in part, similar secretion patterns of GH with man, sheep and pig, though some differences exist from species to species. (auth)

57910 IVth CONFERENCE OF ELECTRON MICROSCOPY, LUBLIN, NOVEMBER 26–28, 1969. Acta Med. Pol.; 12: No. 2, 1-304(1971). (CONF-691138).

Separate abstracts were prepared on two papers. Twelve additional papers discuss the development and applications of electron microscopy. (C.H.)

For abstracts of individual papers see: 58112 and 58113.

57911 CONDITIONS AND PERSPECTIVES OF THE USE OF ISOTOPES AND RADIATION TECHNIQUES IN HORTICULTURE OF FOREIGN COUNTRIES AND OF HUNGARY. Simon, J.; Zsoldos, L. Izotoptechnika; 14: No. 3, 25-33(Mar 1971). (In Hungarian).

Achievements in the field of radiomutation improvement of plants, radiostimulation and conservation of horticultural products, and the use of tracer method are discussed. Research topics and results in Hungarian institutes are included. (auth)

57912 APPLICATION OF AN INDIRECT PAIRED RADIOIODINE-LABELED ANTIBODY TECHNIQUE TO ADENOVIRUS-12 TUMOR SEROLOGY. McCammon, James R.; Yohn, David S. (Ohio State Univ., Columbus). J. Nat. Cancer Inst.; 47: No. 2, 447-54(Aug 1971).

The indirect paired radioiodine-labeled antibody technique was developed to detect antibodies to adenovirus-12-induced tumor antigen(s). This technique was more sensitive than indirect immunofluorescence and markedly more sensitive than complement fixation. It provides a means to rapidly screen large numbers of sera for antibodies to various virus-induced antigens. (auth)

57913 USE OF RADIONUCLIDES IN FOOD SCIENCE AND TECHNOLOGY. Fischer, Erich (Bundesforschungsanstalt fuer Lebensmittelfrischhaltung, Karlsruhe, Ger.). Lebensm.-Wiss. Technol.; 2: No. 1, 1-8(1969). (In German).

A survey was made on radionuclide application in food research and technology. Topics discussed include: the use of radioisotope labeling for the study of milk and milk products; meat; grains, flours, and baking; brewing; packaging materials; and treatment of foodstuff with chemicals. In addition, from the standpoint of the food industry, the survey includes radiometric procedures, natural radioactivity of foodstuff, and neutron activation analysis. 121 references are given. (H.B.G.)

57914 USE OF A DOUBLE-ISOTOPE DERIVATIVE PLASMA ASSAY FOR NORADRENALINE AND ADRENALINE IN THE DIAGNOSIS AND LOCALISATION OF PHAEOCHROMOCYTOMA. Louis, W. J.; Doyle, A. E. (Univ. of Melbourne). Aust. N. Z. J. Med.; 1: No. 3, 212-17(Aug 1971).

A sensitive double-isotope radioimmunoassay method was developed to measure total plasma catecholamines, noradrenaline (NA) and adrenaline (A) in patients with phaeochromocytoma and essential hypertension. Plasma samples containing as little as 0.5 ng of NA or A could be measured accurately. All nine patients with phaeochromocytoma had significant elevations in either total plasma catecholamines or plasma NA. Separation of NA and A with less than 0.3% cross contamination was carried out by thin layer chromatography. This represents a substantial improvement over other methods of assay and raises the possibility that differential plasma assay of NA and A will be of value in diagnosing extraadrenal tumors. Differential plasma NA and A levels were measured in five patients with phaeochromocytoma. Four of these had elevated NA and A levels and were later found to have adrenal tumors. The other patient had a mediastinal tumor and no measurable plasma adrenaline. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 57409, 57418, 57950, 57979, 57995, 57998, 58024, 58105, 58123, 58125, 58154, and 58162.

57915 USE OF RADIOACTIVE IODINE IN DETERMINING THE FUNCTIONAL ACTIVITY OF THE THYROID GLAND OF GERBILS. Akhmetov, I. Z. (Inst. of Zoology and Parasitology, Tashkent). Uzb. Biol. Zh.; No. 2, 61-2(1971). (In Russian).

Iodine-131 was used as a radioindicator of the functional state of the thyroid gland of half-grown gerbils weighing 180 to 200 g. (Rhombomys opimus Lichtenstein). The course of the ^{131}I was followed from the moment of injection of 0.4 to 0.5 mCi under the skin of the rear paw. About 18% appeared in the urine during the first 24 hr; an insignificant fraction appeared in the feces. Between 16 and 20 hr after injection the iodine could no longer be counted. The maximum level of ^{131}I was reached between 8 and 24 hr (28.4 to 26.2% of the initial quantity). (K.S.W.)

57916 COMPARATIVE TOXICITY OF TRITIUM OXIDE FOR VARIOUS TYPES OF ANIMALS. Zhuravlev, V. F. Gig. Sanit.; No. 6, 49-51(Jun 1971). (In Russian).

Data on different sensitivities of animals to the action of tritium oxide are presented. In the study of comparative toxicity various indices were analyzed. The dogs were found to be most sensitive to tritium oxide. The sensitivity of an animal to the action of this isotope depended greatly on the extent of affection of the hemopoiesis and the rate of restoration processes in various types of animals. (auth)

57917 COMPARATIVE BEHAVIOR OF ^{89}Sr AND ^{140}Ba IN THE SKIN AFTER THEIR CUTANEOUS APPLICATION. Shvydko, N. S.; Il'in, L. A.; Norets, T. A.; Antonova, V. A. Gig. Sanit.; No. 6, 45-8(Jun 1971). (In Russian).

Quantitative data are presented on the distribution of isotopes in lipid soluble, water soluble, and residual fractions of the epidermis, dermis, and subcutaneous tissue after application of the isotopes to the skin for 15 and 24 hrs. A comparative analysis of the distribution of ^{89}Sr and ^{140}Ba in the skin was made, and possible mechanisms of fixation of these isotopes in structures of the skin are discussed. (auth)

57918 GROWTH DYNAMICS OF OSTEOSARCOMAS IN BEAGLES. Thurman, Gary Boyd. Salt Lake City; Univ. of Utah (1971). 141p. University Microfilms Order No. 71-20,140.

Thesis.

Two hundred and fifty-six well-documented osteosarcomas have been induced in 201 beagles, each receiving a single intravenous injection of ^{226}Ra (80 tumors), ^{239}Pu (64 tumors), ^{228}Ra (43 tumors), ^{228}Th (56 tumors), ^{90}Sr (8 tumors) or ^{224}Ra (5 tumors). Radiographs of each osteosarcoma were taken during the period of the tumor's growth. The growth dynamics of these osteosarcoma were estimated by measuring the tumor dimensions on as many radiographs as possible. It was clearly evident that the tumor volumes were increasing exponentially with time. Exponential growth constants were calculated for 249 tumors, the corresponding volume doubling times ranged from 4.7 to 60.3 days and averaged 12.4 days. Using individual exponential growth constants, a starting time for each tumor was estimated as the time when the extrapolated tumor's growth curve reached the volume of one cell 10 μ ($\mu = 10^{-4}$ cm) in diameter. The accumulated average skeletal dose during the time from injection to tumor starting time was calculated for each tumor and called the oncogenic skeletal dose. It was found that the larger the amount of radionuclide injected, the larger the oncogenic skeletal dose. High incidences of radiation-induced osteosarcomas in the beagles were noted in vertebrae, pelvic bones, humerii, femora, and tibiae. Radiation-induced osteosarcomas of the vertebrae and pelvic bones had much higher incidences than the corresponding incidences of naturally-occuring osteosarcomas in dogs. (Diss. Abstr.)

57919 ASSESSMENT OF INTERNAL CONTAMINATION RESULTING FROM RECURRENT ON PROLONGED UPTAKES. Recommendations of the International Commission on Radiological Protection. A Report of ICRE Committee 4. ICRP Publication 10A. Oxford; Pergamon Press (1971). 39p. £ 1.25.

Mathematical formulas are presented for use in calculations of the retention and excretion times of a selected list of radioisotopes in man. Factors considered include: declining uptake over an indefinite period following a single exposure (retention of non-transportable radionuclides in the lungs, deposition in pulmonary lymph nodes from contaminated lungs, urinary excretion from contaminated lungs, deposition in the skeleton from contaminated lungs, deposition in the skeleton and excretion after contamination of wounds); and several uptakes during a limited time period (differences between the metabolism of bone-seeking radionuclides and others). Appendices cover: derivation of basic equations, retention and excretion functions for ten radionuclides (^{3}H, ^{90}Sr, ^{132}Te, ^{132}I, ^{131}I, ^{137}Cs, ^{226}Ra, ^{233}U, ^{234}U, ^{239}Pu); the fractions of the total excretion by urine (F_u) and feces (F_f) for elements taken up by extracellular fluid; and data on excretion following periods of constant uptake. (UK)

57920 ENHANCEMENT OF THE CARCINOGENICITY OF 7,12-DIMETHYLBENZ[a]ANTHRACENE THROUGH REPLACEMENT OF HYDROGEN BY DEUTERIUM: A NEW BIOLOGICAL ISOTOPE EFFECT. Buu-Hoi, N. P.; Nguyen, Ba Giao (Centre National de la Recherche Scientifique, Paris). Naturwissenschaften; 58: No. 7, 371(Jul 1971).

Evidence is given to show that 7, 12-dimethylbenz[a]anthracene-d_{16} (I) is, effectively, a significantly more potent carcinogen than ordinary 7, 12-dimethylbenz[a]anthracene (II). The deuterated compound, dissolved in neutral olive oil, was administered subcutaneously to 57 three-month old mice. Each animal received a total dose of 1.5 mg of (I) in three injections at 1-month intervals. Controls were treated with the non-deuterated compound (II). The experiment lasted for 395 days. The tumors observed were fibroblastic sarcomas, either simple or, in a few cases, associated with a baso-cellular or an epidermoid epithelioma. It was concluded that compound (I) is an extremely potent local carcinogen, whose sarcomagenic activity significantly surpasses that of its non-deuterated equivalent (II). (P.C.H.)

57921 CELL LINE INITIATION FROM CORD BLOOD LEUKOCYTES TREATED WITH VIRUSES, CHEMICALS, AND RADIATION. Chang, R. Shihman; Hsieh, Mei-whey; Blankenship, Willard (Univ. of California, Davis. Sacramento Medical Center, Calif.). J. Nat. Cancer Inst.; 47: No. 2, 479-83(Aug 1971).

The initiation of cell lines from leukocytes from human umbilical cord blood treated by the Kaplan cell filtrate, simian virus 40 (SV40), x irradiation, and five chemical carcinogens was attempted. From 45 control and 41 Kaplan cell filtrate-treated cultures, 0 and 19 lines were initiated, respectively. In contrast, SV40, x irradiation, and the five chemical carcinogens used were ineffective in initiating cell lines. (auth)

57922 FATE OF ^{252}Cf IN THE RAT. Mewhinney, James Albert. Lafayette, Ind.; Purdue Univ. (1971). 129p. University Microfilms Order No. 71-20,506.
Thesis.

The retention, excretion and distribution of ^{252}Cf citrate injected into the intraperitoneal cavity of male rats weighing 120 to 140 grams were studied for periods up to 64 days after injection. All quantification of ^{252}Cf was accomplished with an external sample liquid scintillation counting system calibrated to detect the emissions from the spontaneous fission decay of the radionuclide. Whole body retention of ^{252}Cf was determined on a group of 5 rats over the 64 day period. A three component exponential equation was fitted to the mean daily retention data using a nonlinear weighted regression analysis program. The fitted equation $BB(t) = 22.85e^{-3.05t} + 15.69e^{-0.081t} + 61.46e^{-0.00065t}$ had a computed correlation coefficient of $(r) = 0.996$ indicating the equation was an adequate description of the data. The calculated effective partial half-lives corresponding to these three components were 2.2 hours, 8.5 days since 1072 days. The long term component is longer than the physical half-life of 966 days, an impossibility The lower limit of the nonlinear 95% confidence interval about this long term component gives a calculated effective partial half-life of 700 days. Thus, the true effective partial half-life is probably between 700 and 966 days. The daily excretion of ^{252}Cf was greatest in the urine for the first 24 hours after injection when 20% of the initial body burden was eliminated. Thereafter fecal excretion was predominant throughout the 64 day experiment period. The total accumulative excretion data closely supported the whole body retention data obtained by whole body counting. The organ and tissue distribution of ^{252}Cf was determined in a serial sacrifice experiment. Groups of six rats were injected and maintained for periods of 1, 2, 4, 8, 16, 32 and 64 days. Initial deposition of ^{252}Cf was greatest in the skeleton with 60.4% of the initial body burden being retained at one day. The skeleton retained this deposition tenaciously, only about 8% of the initial activity was lost in 64 days. The liver, gastrointestinal tract, kidney, and soft tissues initially deposited 7.48, 2.26, 1.98 and 2.00% of the initial body burden. The content of ^{252}Cf in these organs and tissue had declined to less than 1% of the initial body burden by 32 days after injection. The localization of ^{252}Cf in the femur was studied using alpha autoradiography. Sections of undecalcified bone were exposed on 50 micron-thick NTA emulsion slides and developed in the normal manner. Alpha track counting techniques were used to assess the relative radiation dose to the endosteal periosteal and Haversian system of bone surfaces. Assuming that the radiation dose to the above surfaces directly related to the number of alpha particles detected, the periosteal surface received nearly twice the radiation dose as the endosteal surface due to initially deposited ^{252}Cf. However, remodeling grossly changed this pattern of dose distribution in both time and space. Apposition and resorption on bone surfaces caused the relative radiation dose to bone surfaces to vary by factors as large as 25 to 50. (Diss. Abstr.)

57923 PULMONARY CELL RESPONSES TO METALLIC OXIDES. Casarett, Louis J.; Casarett, Margaret G.; Whalen, Stephanie A. (Univ. of Hawaii, Honolulu). Arch. Intern. Med.; 127: 1090-8(Jun 1971).

When the phagocytic response of pulmonary cells obtained from rat lung lavage to insoluble particles was assessed in an in vitro system under conditions of selected variables, a peak phagocytic response occurred for most metal oxides (except Fe_2O_3) at 10^{-4} M Ca^{2+} and at 10^{-7} M UO_2^{2+} in a simple saline medium. The Ca^{2+} effect was interrelated with particle concentration for SiO_2 particles. Phagocytic response increased with particle to cell ratios up to 10 to 15 with several particle species. These and other data including enhanced phagocytosis with poly-L-lysine, are discussed in relation to peritoneal cell responses, charge characteristics of particles, and the implications of the findings to in vivo lung responses. (auth)

57924 FLUID AND ELECTROLYTE SPACES IN CHRONIC RENAL INSUFFICIENCY. Vorburger, Chr. (Staedtisches Krankenhaus, Baden, Ger.). Helv. Med. Acta, Suppl.; No. 51, 1-142(1971). (In German).

Discussed is the isotope dilution principle and the physiological behavior of tritium-labeled water, ^{24}Na, ^{42}K, and ^{82}Br. By means of these isotopes, simultaneous determination was performed for exchangeable body sodium, exchangeable body potassium, the ^{82}Br distribution space, total-body water content, and plasma volume. The study included investigations on all patients in the chronic hemodialysis station of the medical outpatient clinic at the university of Bern and 44 conservatively treated chronic uremic patients; in all, 83 isotope studies were done. Results showed a significant correlation between blood pressure and all of the extracellular fluid spaces. While in 90% of the patients high blood pressure disappeared with correction of the excess fluid, 10% retained hypertension. All of the patients who showed a pathological glucose tolerance also showed a reduction in intracellular potassium. (H.B.G.)

Radiation Effects

Refer also to abstracts 57951, 57952, 57958, and 58119.

57925 EFFECTS OF ULTRAVIOLET IRRADIATION ON DNA SYNTHESIS IN CHLAMYDOMONAS REINHARDI. White, Michael Thomas. Los Angeles; Univ. of California (1971). 148p. University Microfilms Order No. 71-21,343.
Thesis.

The dark repair of DNA following UV irradiation was investigated in the wild type of the unicellular green alga Chlamydomonas reinhardi. Experiments with radioactive nucleic acid precursors suggested that pyrimidines are not incorporated into DNA to any appreciable extent in this organism. This precluded quantitative experiments that would demonstrate excision of pyrimidine dimers as a model of DNA repair. In the dark cells with ^{3}H-thymidine prelabeled DNA responded to UV irradiation by releasing ^{3}H into the growth medium and a decreasing specific activity of ^{3}H in DNA. Since pyrimidine dimers could not be demonstrated, the release of label was only suggestive of excision repair. Repair replication was investigated by density transfer experiments and observation of unscheduled DNA synthesis. Synchronized cultures incorporated ^{32}P label into DNA in the dark following UV irradiation. Control cultures incorporated little label for up to 4 hours of dark incubation. Apparently, UV irradiation stimulates DNA synthesis in the dark under conditions where DNA synthesis would not normally occur. Density transfer experiments were performed using ^{15}N as a heavy density DNA label. Attempts to characterize repair replication as single stranded DNA showing hybrid density were unsuccessful. This was due to poor resolution between heavy and light density single-stranded DNA, and the apparent instability of Chlamydomonas DNA to denaturation. Taken together, the results suggest repair, but in general, attempts to identify and characterize dark repair in this organism were unsuccessful. (Diss. Abstr.)

57926 CAROTENOIDS ACCUMULATION AND CHANGES OF CAROTENOID PATTERN OF JAPANESE PERSIMMON BY CATHODE RAY IRRADIATION. **Umeda, Keiji (Food Research Inst., Tokyo); Shiroishi, Masahide. Nippon Shokuhin Kogyo Gakkaishi; 18: No. 4, 161-6(Apr 1971). (In Japanese).**

The effect of cathode ray irradiation on the carotenoids of Japanese persimmon Hiratanenashi and Yotsumizo was investigated. Carotenoid patterns of Yotsumizo varied at different stages of maturity and the chemical composition of the carotenoid group in fully ripe Yotsumizo was hydrocarbon: 15.6%, monol: 19.3%, Diol: 20.9%, diol monoepoxide: 15.4%, diol diepoxide: 24.4%, and polyol: 5.4%. Nearly ripe Yotsumizo were irradiated at 0.1 and 0.3 Mrad and analyzed for total carotenoids and carotenoid patterns at 5, 8, and 12 days after irradiation. Total carotenoid content in 0.1 Mrad samples was higher than that in the non-irradiated samples throughout the experiment and 8 days after irradiation it reached the maximum value of 1.4 times as much as in non-irradiated samples. Total carotenoid content in 0.3 Mrad samples was 1.3 times as much as in non-irradiated samples at 5 days after irradiation, but it decreased rapidly and was less than that of non-irradiated samples subsequently. Carotenoid patterns of 0.1 Mrad samples were similar to those of ripe samples throughout the experiment, but the patterns of 0.3 Mrad samples changed in each analysis. These differences between 0.1 and 0.3 Mrad suggest that irradiation activated normal carotenoid biosynthesis in the case of 0.1 Mrad, while on the other hand, there was a disturbance of carotenoid biosynthesis in 0.3 Mrad. Irradiation at 0.3 Mrad caused a temporary carotenoid accumulation at 5 days after irradiation. (auth)

57927 RADIOSENSITIVITY OF THE RADIATION INDUCED AMINOPTERIN RESISTANT YEAST CELLS. **Munechika, Hirotugu; Kitahara, Takashi; Ishikawa, Nobuyuki; Kamakazu, Kiyomaro; Kiga, Masami (Showa Univ., Tokyo). Nippon Igaku Hoshasen Gakkai Zasshi; 30: No. 6, 518-24(Sep 1970).**

Aminopterin-resistant cells were induced by the x irradiation of yeast cells. Assuming that even a slight disturbance of thymidine mononucleotide (TMP) synthesis caused by radiation was related to the cell damages, it was expected that a correlation exists between radiation resistance and aminopterin resistance. In the present experiments, comparative studies of radiosensitivity were carried out on both original and resistant cells to evaluate this correlation in yeast cells. It was shown that the aminopterin-resistant cells were more radioresistant than the original cells, and that the original cells became more radioresistant by TMP pretreatment. Under these conditions, it was shown that while hydroxyurea or an excess of deoxyuridine mononucleotide (duMP) inhibited the growth of aminopterin-resistant cells, an excess of deoxyadenosine as well as of TMP never inhibited growth. From these evidences, it was proposed that the path way from duMP to TMP was closely related to the radiosensitivity. (auth)

57928 ENZYMATIC REPAIR OF DEOXYRIBONUCLEIC ACID. IV. MECHANISM OF PHOTOPRODUCT EXCISION. **Kushner, Sidney R.; Kaplan, Joan C.; Ono, Howard; Grossman, Lawrence (Brandeis Univ., Waltham, Mass.). Contract AT(30-1)-3449. Biochemistry; 10: No. 18, 3325-34(31 Aug 1971).**

The enzymatic mechanisms controlling the incision and excision of uv-irradiated Escherichia coli DNA have been examined. The uv-endonuclease, which catalyzes the incision step in repair, hydrolyzes a single phosphodiester bond, 5′ to the photoproduct region. This step is associated with the formation of a 3′-phosphoryl group on the DNA and a 5′-hydroxyl group either at, or one nucleotide 5′, to the photoproduct. The release of either nucleotides or photoproducts does not occur at any significant extent under these circumstances. The excision of nucleotides, and those containing photoproducts, from incised DNA is dependent on the unique exonucleolytic properties of a second enzyme, the uv-exonuclease. This enzyme catalyzes the release of approximately seven nucleotides for each phosphodiester bond hydrolyzed during the incision of irradiated E. coli DNA. There are ten nucleotides released during the excision for each incision event of irradiated Micrococcus luteus DNA. The cavity of the excised E. coli DNA is terminated by two phosphoryl groups. A 3′-phosphoryl group arises from incision and after the excision event a 5′-phosphoryl group remains. Chromatographic analyses of the products released during the initial phases of excision revealed that oligonucleotides were liberated and subsequently degraded exonucleolytically by the same enzyme. It is concluded that the primary hydrolytic event during excision is endonucleolytic in nature. Moreover, the distribution of nucleotides 3′ to the photoproduct in the excised fragment from irradiated E. coli DNA is enriched in adenine and thymine containing deoxynucleoside 5′-monophosphates. As the irradiation is intensified this distribution is modified to include cytosine-containing deoxynucleotides. The significance of these findings is discussed. (auth)

57929 RADIATION-INDUCED CHANGE OF ENZYME ACTIVITY DURING BLOCKING OF THE ADRENAL CORTEX. **Khrypchanka, I. P.; Kukulyanskaya, M. F. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 3, 81-4(1971). (In Belorussian).**

Cholinesterase and hexokinase activity was studied in the cerebral hemispheres and cardiac muscle of rats during fractional dosages of the animals with x-radiation. (13 R + 13 R + 14 R = total of 40 R). In order to define more accurately the effect of radiation the adrenal cortex was blocked with subsequent hormone therapy. The role of the adrenal hormones was considered in connection with the inhibitory effect of radiation, in particular on the brain and heart hexokinase during adrenalectomy. Changes in cholinesterase in these tissues are discussed. (tr-auth)

57930 PULSE-RADIOLYSIS STUDIES OF SOME NUCLEIC ACID FRAGMENTS IN AQUEOUS SOLUTIONS. **Fel, N. S.; Zaozerskaya, L. A.; Dolin, P. I. (Inst. of Electrochemistry, Moscow). Radiat. Eff.; 9: No. 3-4, 145-52(Jun 1971).**

The optical absorption spectra of short-lived products in 1–2×10^{-3} M solutions of pyrimidine bases (PB): thymine (T) and uracil (U) saturated with He and N_2O (pH = 1.2 and 7) have been measured by the pulse radiolysis method. For T and U the spectra of the products of reactions OH + PB, H + PB, and e^-_{aq} + PB are similar in shape and intensity ($E_{380} = 400 \pm 150\ M^{-1}\ cm^{-1}$) and show two maxima (at ~300 and ~380 nm). An additional reaction occurs along C_6 to form $(P\dot{B})OH$ and $(\dot{P}B)H$ radicals; reaction with e^-_{aq} involves fast protonation. C_6 is practically the only place of attack for OH, H, or e^-_{aq}. In solutions of deoxyribose (DOR), the rate constant of the reactions between e^-_{aq} and DOR (it is equal to $(1 \pm 0.5) \times 10^7\ M^{-1}\ sec^{-1}$) has been measured as well as the optical adsorption spectra of the short-lived products of reactions OH + DOR and e^-_{aq} + DOR. From the comparison of the absorption spectra of the short-lived radiolysis products of thymine and thymidine solutions, it has been found that the only place of primary attack on the nucleoside molecule by the OH radical is the base. and e^-_{aq} + DOR. From the comparison of the absorption spectra of the short-lived radiolysis products of thymine and thymidine solutions, it has been found that the only place of primary attack on the nucleoside molecule by the OH radical is the base. A study has been made of uracil solutions in the presence of oxygen. The spectrum of the peroxide radical $UOH\dot{O}_2$ has been obtained ($\lambda_{max} \leq 300$ nm, $E_{300} = (280 \pm 70)\ M^{-1}\ cm^{-1}$) and the rate constant of reaction $\dot{U}OH$ with oxygen has been measured: $(1.6 \pm 0.5) \times 10^9\ M^{-1}\ sec^{-1}$. (auth)

57931 STUDIES OF RADIATION BIOCHEMISTRY IN PLANTS. II. EFFECT OF CHRONIC GAMMA-IRRADIATION ON METABOLISM OF AMINO ACIDS AND SUGARS IN PEA AND WHEAT PLANTS. **Jiracek, V.; Kryzanek, R.; Kostir, J. (Charles Univ., Prague). Rostlinna Vyroba; 16: No. 6, 657-70 (Jun 1970). (In Czech).**

Chronic ^{60}Co γ-irradiation of pea and wheat plants in field experiments affected the content of amino acids and saccharides in above-ground parts and in the roots; this affected not only the irradiated X_0 generation but also filial non-irradiated generations X_1 and X_2. Irradiation of wheat and pea plants affected mainly the content of glutamic acid and of metabolically related amino acids (glutamine, γ-amino-butyric acid, proline) and also serine, threonine, and glycine, arginine, and lysine. Decrease in the content of glutamic acid in the above-ground parts of young pea and wheat plants of generation X_0 was accompanied by increase in the content of γ-aminobutyric acid. A similar relation was found in the above-ground parts of young wheat plants of the X_1 and X_2 generations. This was not the case in pea plants, which pointed to a higher activity of glutamatedecarboxylase. Changes in the content of arginine and lysine affected pea plants significantly only in the X_0 generation while in wheat the effect was found also in X_1 and X_2 generations. Chronic irradiation inhibited the biosynthesis of saccharose in pea plants of all three generations (X_0, X_1, X_2) while in wheat only the X_0 generation was affected. Irradiation also retarded the formation of the glucoside of pisato-

XUM

side in the above-ground parts of peas in all three generations, though in young plants only. Also the transport of fructose from the above-ground parts to the roots of peas and wheat was affected (NSA of Czech)

57932 RADON IRRADIATION OF RAT TISSUE AND ORGANS. Pegel, V. A.; Dokshina, G. A.; Sukhanova, G. A. (Tomsk Univ., USSR). Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol. Nauk; 3: No. 15, 128-31(Dec 1970). (In Russian).

The dynamics of oxidative phosphorylation in the rat was studied after irradiation with radon. Rats were injected with 0.2 μCi/gram (radon in equilibrium with its decay products), and then examined at intervals up to 48 hr afterwards for ATP/ADP content in rat tissue and for liver mitochondria. The data indicated that the ATP content was lowered by irradiation by 14 to 62%, the maximum drop being in the spleen within one day. The ATP activity of the liver mitochondria in the rat did not change in the first 24 hr. However, the processes of oxidative phosphorylation of mitochondria which had been removed from the liver were disrupted only 2 to 4 hr after irradiation. (K.S.W.)

57933 CHANGES IN ACTIVITY OF AMINOTRANSFERASE IN MITOCHONDRIA OF TISSUE IN IRRADIATED ANIMALS. Chernoguzov, V. M.; Pikulev, A. T. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 4, 75-80(1971). (In Belorussian).

The activity of aspartine-aminotransferase and alanine-aminotransferase in mitochondria was investigated from liver tissue, heart muscle, and brain of intact, adrenalectomized rats which had been exposed to 700 R of whole-body x-radiation. Changes in the ratio of activities of free and combined forms of these ferments in mitochondria were investigated at various intervals after the irradiation. Their dependence on the type of tissue as the source of mitochondria was studied. Possible mechanisms were discussed for the individual changes, and for the role of suprarenal hormones. (tr-auth)

57934 NEW IMMUNOGLOBULIN-LIKE MOLECULES IN THE SERUM OF BURSECTOMIZED-IRRADIATED CHICKENS (HEAVY-(μ)CHAIN/IMMUNOELECTROPHORESIS/AGAMMAGLOBULINEMIA). Choi, Young Sung; Good, Robert A. (Univ. of Minnesota, Minneapolis). Proc. Nat. Acad. Sci. U. S. A.; 68: No. 9, 2083-6 (Sep 1971).

A new immunoglobulin-like protein that was found in the sera of bursectomized and irradiated chickens is reported. Unlike IgM and IgG, this protein is apparently made only of heavy chains of IgM and contains no light chains. (auth)

57935 ENZYMATIC REPAIR OF DNA. III. PROPERTIES OF THE UV-ENDONUCLEASE AND UV-EXONUCLEASE. Kaplan, Joan C.; Kushner, Sidney R.; Grossman, Lawrence (Brandeis Univ., Waltham, Mass.). Contract AT(30-1)-3449. Biochemistry; 10: No. 18, 3315-24(31 Aug 1971).

Two enzymes have been purified from Micrococcus luteus which together are responsible for the in vitro excision of photoproducts from uv-irradiated DNA. The first enzyme, uv-endonuclease, catalyzes the formation of single-strand incisions in irradiated duplex DNA. It is inactive on native, irradiated denatured, and unirradiated denatured DNA. The apparent K_m value for irradiated native DNA is equal to 1.25×10^{-5} M at 37° and the pH optimum is between pH 7.0 and 7.5. The UV-endonuclease is stimulated by but not dependent on Mg^{2+}. This enzyme is not inhibited by EDTA or caffeine. Acridine orange is inhibitory at high concentrations (1×10^{-2} M). Based on gel filtration, this enzyme has been assigned a molecular weight of 15,000. The DNA substrate-dose dependency relationship is correlated with uv-endonuclease activity. A direct correlation exists between the number of pyrimidine dimers formed and the number of single-strand breaks which in turn is dependent on the DNA source. The second enzyme, uv-exonuclease, degrades exposed regions of DNA resulting from incision by the uv-endonuclease. The uv-exonuclease hydrolyzes unirradiated and irradiated heat-denatured DNA at equivalent rates and to the same extent but does not attack native DNA or RNA. Unlike most known exonucleases, it is not inhibited by the presence of photoproducts in DNA. The apparent K_m value for irradiated denatured DNA is equal to 4.46×10^{-6} M at 37°. The pH optimum lies between pH 7.0 and 7.5 and the enzyme requires Mg^{2+} for activity. It is inhibited by Mn^{2+}, Ca^{2+}, Zn^{2+}, and EDTA. An unusual feature of this enzyme is the sigmoidal shape of its enzyme concentration curve. The initial lag in this curve can be abolished by certain monovalent cations: K^+, NH_4^+, Na^+, or Li^+. The uv-exonuclease is characterized with respect to its activity on denatured DNA. It degrades this substrate from both the 3′ and 5′ termini in an exonucleolytic manner, yielding as its final degradation product, 5′-mononucleotides. When irradiated denatured DNA is hydrolyzed to completion, the major products are mononucleotides although some tri- and tetranucleotides are also released. Single-stranded polydeoxythymidylic acid, poly $[d(pT)_{200}]$, is degraded entirely to mononucleotides but the digestion products of irradiated poly$[d(pT)_{200}]$ comprise a mixture of mono-, di-, and trinucleotides. (auth)

57936 ADENINE NUCLEOPROTEIDES IN DIFFERENT STAGES OF PHOSPHORYLATION IN LIVER AND KIDNEY OF WHITE RATS SUFFERING FROM RADIATION SICKNESS. Mytareva, L. V. Tr. Leningrad. Khim.-Farm. Inst.; No. 20, 167-72(1969). (In Russian).

The effect of x-radiation on the content and ratio of adenine nucleotides of different degrees of phosphorylation in rat liver and kidney was studied. White rats of both sexes received 1,000 R doses of x-rays at 78 R/min; livers and kidneys were removed at intervals from controls and irradiated animals, and the free adenine nucleotides were determined by paper electrophoresis. Adenosine triphosphate content of the liver had decreased in 2 to 3 hr after irradiation, but was restored in 24 hr, and subsequently fell again. Adenine triphosphate content of the kidney fell in 24 hr. A decrease in all three adenine nucleotides was observed in the liver, but no change occurred in the kidney. (K.S.W.)

57937 STUDY OF LACTATE DEHYDROGENASE ACTIVITY IN CERVICAL CANCER. Iwakura, Tomikazu (Tokyo Medical Coll.). Tokyo Ika Daigaku Zasshi; 27: No. 6, 765-95(Nov 1969). (In Japanese).

Enzyme activity levels in the sera and portio vaginalis tissues from 95 cervical cancer patients were measured before and after ^{60}Co irradiation. Enzyme activity levels in basement epithelia of normal portio vaginalis tissues from 65 non-cancer patients were also studied for comparison. Serum lactate dehydrogenase (LDH) levels in cervical cancer patients were higher than in non-cancer patients. These levels decreased following irradiation at doses of 500 to 1000 R, and increased at doses above 1000 R. Serum activity levels for other enzymes did not differ significantly between the cancer and non-cancer patients, nor was a radiation effect observed as in the case of LDH activity levels. In irradiated tissues, the changes in LDH activity levels were greater in those tissues showing larger histopathological changes. Changes in the histochemical activities in irradiated cancer tissues were great at 1000 R but decreased as the dose was increased above 2000 R. A correlation between decreased histochemical activity and the prognosis for recovery (3-yr recovery rate) was noted. (TSS)

57938 EFFECT OF ACTH ON THE SYMPATHICO-ADRENAL SYSTEM IN DEALING WITH RADIATION SOURCES. Kogan, I. A. Gig. Tr. Prof. Zabol.; No. 9, 24-6(Sep 1971). (In Russian).

The question as to the influence exerted by ACTH on the medullar layer of the adrenals has not been dealt with sufficiently in literature sources. This study covered the effect of ACTH on the excretion of catecholamines in persons dealing with various sources of ionizing radiation. Epinephrine and norepinephrine were determined after V. O. Osinskaya as modified by Baru. A total of 81 subjects, including 17 controls, were examined. Depending upon the summary irradiation dosage, all examinees were divided into four groups, viz. from 5 to 30 R; from 30 to 70 R; from 70 to 150 R; and from 150 to 400 R. In healthy persons, introduction of ACTH brought about on day 2 to 3 of investigation an increase of the epinephrine and a fall of the norepinephrine excretion. With increased radiation dose, the excretion of catecholamines diminished in all periods of the study (weakening of compensatory mechanisms). (auth)

57939 ULTRAVIOLET RADIATION EFFECTS ON ISOLATED NERVE FIBERS. Lieberman, Edward M. (Wake Forest Univ., Winston-Salem, N. C.). Advan. Biol. Med. Phys.; 13: 329-50 (1970).

Nerve-muscle preparations and isolated axons from the walking leg of the blue crab, Callinectes sapidus, were used in the experiments. Action spectrum data suggest that the target of irradiation is the excitable membrane. It is thought that the effects of ultraviolet radiation are on the inner and outer protein layers of the axonal membrane. Evidence from the studies indicates that a nucleotide-like molecule is directly involved in excitability characteristics of nerve. It was concluded that the structural and functional components of the membrane system responsible for the operation of the excitability system are common to the transport ATPase and ATP dependent Ca^{2+} binding properties of the membrane. (H.L.W.)

57940 EFFECT OF GAMMA RADIATION ON THE PHOSPHOLIPASE A ACTIVITY OF THE STICKER SARCOMA. Lloveras, Jacques; Douste-Blazy, Louis (Univ., Toulouse). Compt. Rend., Ser. D; 272: No. 20, 2641-3(17 May 1971). (In French).

The Sticker sarcoma of the dog contains an A phospholipase acid (optimum pH 4.5) which is localized principally in the lysosomes and mitochondria; it is present in very small quantities in the microsomes and absent from the soluble fraction. Gamma irradiation (500 rads) enhanced this enzymatic activity after the fifteenth minute in mitochondria, lysosomes, and microsomes and induced its appearance in the soluble fraction. (auth)

57941 STUDIES OF RADIATION BIOCHEMISTRY IN PLANTS. I. CHRONIC EFFECT OF GAMMA IRRADIATION ON PHOSPHORUS METABOLISM IN PEA AND WHEAT. **Jiracek, V. (Charles Univ., Prague); Kryzanek, R.; Votruba, I.; Kostir, J. Rostlinna vyróba; 16: No. 6, 645-56(Jun 1970). (In Czech).**

The effect was studied of chronic γ-irradiation on the dynamics of phosphorus-containing substances in pea and wheat plants in field experiments. The content of various fractions of phosphorus was examined in both the irradiated X_0 generation and in two non-irradiated F-generations (X_1 and X_2). Ionizing radiation stimulated the intake of phosphorus. This resulted in an increased total P content, especially in the above-ground parts of pea and wheat plants of generation X_0. The content of phosphorus insoluble in ethanol and of phosphorus soluble in acids was increased. The content of both fractions of phosphorus increased also in wheat roots while it decreased in pea. The content of phosphorus soluble in ethanol (represented mainly by phospholipides) decreased in the above-ground parts and in the roots of generation X_0 of wheat, while it increased in pea, except for the roots of some old plants. The content of nucleic acids markedly increased in the above-ground parts of wheat of the X_0 generation, whereas its increase in pea was less significant. It decreased in the roots of both pea and wheat. The content of RNA increased significantly in the above-ground parts of both young and old wheat plants, while in pea it increased only in young plants. The content of DNA mostly decreased in the above-ground parts of young plants of both pea and wheat. Changes induced by ionizing radiation were less marked in the X_1 and X_2 F-generations of both pea and wheat, in which reparation processes had already started. (NSA of Czech)

57942 EFFECTS OF ULTRAVIOLET AND VISIBLE LIGHT ON NERVE FIBERS AND CHANGES IN OPTICAL PROPERTIES DURING NERVOUS ACTIVITY. **Tasaki, Ichiji (National Inst. of Mental Health, Bethesda, Md.). Advan. Biol. Med. Phys.; 13: 307-27(1970).**

The effects of uv and visible light on the electrophysiological activity of the nerve fiber are reviewed. Unstained nerve fibers strongly absorb uv shorter than about 300 nm wavelength and are injured by the absorbed uv. Nerve fibers stained with various dyes are sensitized to the light absorbed by the dyes. The macromolecular approach to the process of nerve excitation is reviewed. The subunits, of which the nerve membrane is composed, are considered to exist in either one of the two distinct conformational states. Transition of a subunit from one state to the other is brought about by a cooperative ion-exchange process involving univalent and divalent cations occupying the anionic sites of the membrane macromolecules. The importance of the eddy (local) currents in the process of nerve excitation is stressed. The molecular basis of the process of nerve excitation is examined by staining nerve fibers with various dyes. It is possible to detect changes in the intensity of fluorescence during the action potential. The dye technique offers powerful means of elucidating physicochemical properties of the nerve membrane. The biochemical processes leading to the photosensitization effect of dyes are not clear at present. (auth)

57943 REPAIR OF DNA IN MAMMALIAN CELLS. **Painter, R. B. (Univ. of California, San Francisco). Curr. Top. Radiat. Res.; 7: No. 1, 45-70(Sep 1970).**

Several kinds of DNA repair are known to occur in mammalian cells. Of these, single-strand rejoining and repair replication have been most intensively studied. It now seems probable that, after x-irradiation, the rejoining of single-strand breaks involves repair replication. On the other hand, the first step in excision repair after uv-irradiation is the formation of a single-strand break by enzymes within the cell. Therefore, these two phenomena are probably closely related and in many cases may reflect the same repair system. A relatively newly discovered repair system, recombination repair, occurs in DNA made after damage has occurred. This may be of greater importance in mammalian cells after uv-irradiation than is excision repair, since many mammalian cells apparently do not excise dimers. Even this repair system, however, probably utilizes some or all of the same enzymes that operate in excision repair. These repair systems undoubtedly are important in recovery from potentially lethal and sublethal damage in mammalian cells, but their exact roles are still not clear. Photoreactivation occurs in marsupials but apparently not at all in cells from placental animals. (auth)

57944 AUTORADIOGRAPHIC STUDY OF THE EFFECT OF X RAYS ON DNA AND RNA SYNTHESIS DURING SEGMENTATION AND GASTRULATION OF PLEURODELES WALTII MICHAH. **Alexandre, Henri (Univ, Brussels). Arch. Biol. (Liege); 81: 139-62(1970). (In French).**

Young pleurodele embryos were irradiated at the following stages: 2 to 4 blastomeres, morula, blastula and gastrula. The use of nucleic acid precursors administered by microinjection shows that x-rays applied to cleaving eggs inhibit DNA replication and mRNA synthesis in proportion to the dose given, and that this results in an arrest of development of the advanced blastula stage. The metabolic pathway leading to the incorporation of ^{3}H uridine into DNA is extremely radiosensitive in young embryos. It was also demonstrated that the lower level of radiosensitivity observed in gastrulas results in a higher resistance to x-rays of the synthesis of DNA from thymidine: the metabolic pathway whereby DNA is synthesized by incorporation of uridine is still very much altered by irradiation. (auth)

57945 PRELIMINARY STUDIES ON THE CHANGES IN THE ELECTROPHORETIC MIGRATION PROFILE OF THE PROTEINS IN HUMAN SALIVA DURING ANTI-PLASTIC RADIATION THERAPY. **Pini Prato, G. (Univ., Florence). Riv. Ital. Stomatol.; 25: No. 11, 1042-6(Nov 1970). (In Italian).**

The effect of radiation therapy on the electrophoretic pattern of human salivary proteins has been studied in 20 patients, subjected to radiation for antiblastic therapy. A loss of some cationic fast migrating components of the salivary proteins has been observed in 3 cases. This finding is discussed briefly in connection with the problem of the effect of radiation on animal cells. (auth)

Immunology

Refer also to abstracts 58072, 58104, and 58120.

57946 INVESTIGATIONS ON IMMUNITY DEVELOPED IN CHICKENS AGAINST ASCARIDIA GALLI USING IRRADIATED EGGS OF THIS HELMINTH. **Deo, P. G.; Sokolic, A.; Gangadhara Rao, Y. V. B. (Indian Veterinary Research Inst., Izatnagar). Indian J. Anim. Sci.; 41: No. 4, 306-10(Apr 1971).**

Double vaccination—first at 20 days of age with 500 irradiated eggs of A. galli and second at 35 or 50 days with 1,000 such eggs—induced strong immunity against the challenges with 1,000 normal (non-irradiated) eggs at 50, 65, 80 and 95 days. The eggs were irradiated at 10 kR of gamma-rays delivered from ^{60}Co source. The immunity developed by vaccinations at 20 and 50 days appeared steadier than that produced by vaccinations at 20 and 35 days. Irradiation of eggs completely inhibited the development of male worms. Such vaccinations improved the weight-gain in chickens. Various immunization schedules are discussed briefly. (auth)

Ecology

Refer also to abstracts 57351, 57979, 57980, 57981, 57983–57985, 57987–57994, 57996, 58079, 58138, and 58150.

57947 (CONF-710501-35) ERROR ANALYSIS OF ECOLOGICAL MODELS. **O'Neill, R. V. (Oak Ridge National Lab., Tenn.). [1971]. 32p. Dep. NTIS.**

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

Systems analysis techniques are valuable in the analysis of radionuclide kinetics in ecosystems. However, the art of systems modeling is relatively new to ecology and few guides are available for constructing ecological models. As a result, untested hypotheses are sometimes involved in model development. For example, it may be difficult to predetermine optimal model complexity, i.e., the number of state variables or compartments to be included in a model for acceptable accuracy. The hypothesis that greater complexity leads to greater accuracy was tested by analyzing the total uncertainty accompanying a model prediction. In general, systematic bias, resulting from abstracting the system into a few variables, is inversely related to complexity. However, there is a concomitant increase in uncertainty due to measurement errors on individual model parameters. As more parameters are added to the model, they must be quantified in field and laboratory experiments which are never error-free. If these measurement errors are promulgated through a simulation, they contribute to uncertainty in model predictions. By applying Monte Carlo simulation techniques, it was possible to account explicitly for each component of the total uncertainty. Particular attention was paid to the balance between systematic bias and measurement errors. This analysis indicated that the gain in precision from increasing model complexity is not as consistent an outcome as might be expected. Results appear valid for a wide range of modeling applications. (auth)

57948 (SWRHL-85-r) RADIONUCLIDE STUDIES WITH DAIRY COWS FOLLOWING TWO PLOWSHARE EXPERIMENTS. Black, Stuart C.; Bretthauer, Erich W.; McNelis, David N. (Western Environmental Research Lab., Las Vegas, Nev.). Sep 1971. 32p. Dep. NTIS.

Baled hay was placed on the ground in the predicted trajectory of the effluent from the two Plowshare cratering tests, Cabriolet and Buggy. After contamination, the bales were collected and measured amounts of the hay were fed to groups of dairy cows. As compared to similar experiments following other cratering tests, the amount of ^{131}I transferred to milk was about one-third, and the time to peak milk concentration and effective half-life in milk were longer. The ratio of peak ^{131}I concentration in milk to the peak concentration in hay was also much less than that observed in previous tests. These facts suggest that the ^{131}I in the debris from these two tests was less biologically available to the cow than it was in previous tests. For Project Buggy, the transfer of ^{187}W to milk was also measured. Less than 0.5% of the tungsten ingested with the hay was secreted in milk and the measured half-time in milk was about 2.5 days. (auth)

57949 PHOSPHORUS FEEDING OF BUCKWEAT AND YELLOW LUPINE IN PURE AND MIXED PLANTS. Zabyalendzik, S. F. (Inst. of Experimental Botany, Minsk). Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 3, 25-9(1971). (In Belorussian).

The seasonal rhythm and uptake rate of labelled phosphorus were studied in buckwheat and lupine under conditions of growth in pure and mixed stands. Buckwheat absorbed phosphorus faster than lupine by a factor of two in pure stands, and by a factor of seven in mixed. Maximum ^{32}P uptake was noted in the budding stage of buckwheat, but in lupine the stalk-development phase. Minimum ^{32}P uptake occurred in buckwheat during ripening; in lupine during the bean stage. (tr-auth)

57950 ^{32}P TRANSMISSION FROM PLANT TO PLANT. Min'ko, I. F. (Inst. of Experimental Botany, Minsk). Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 3, 20-4(1971). (In Belorussian).

Plant-to-plant transmission of ^{32}P was studied in pure and blended plants of vetch and oats. Vetch showed uptake of ^{32}P through both leaves and roots, although the root system was more effective. Transmission of ^{32}P in pure vetch was twice as effective as in pure oats. Vetch-to-oats transmission was 1.5 to 2 times better, and from oats-to-vetch it was lowered by 20 to 25% in comparison to the pure crop. Transmission dropped with increasing age of the vetch or oat plants. (tr-auth)

Genetics and Cytogenetics

Refer also to abstract 57999.

57951 (COO-1747-6) RADIATION INDUCED DNA SYNTHESIS IN THE POLYTENE CHROMOSOMES. Valencia, Juan I.; Plaut, Walter (Wisconsin Uni.v., Madison. Dept. of Zoology). [1970]. 18p. Dep. NTIS.

Salivary gland chromosomes of Drosophila melanogaster were irradiated with 1,000 to 100,000 R x rays and a dose of 1800 ergs/mm^2/sec of ultraviolet. Following incubation in tritiated thymidine, nuclei were analyzed for frequency of labeled nuclei, proportion of discontinuous and continuous labeling, frequency of labeling at specific loci and frequency of joint labeling at normally correlated loci, iso-labeling at homologous loci in unpaired regions of homologous chromosomes, and distribution of autoradiographic grains across versus along the chromosome axis. The results showed that a range of doses of x rays and ultraviolet radiation induced a kind of DNA synthesis in the salivary gland nuclei that could be detected by the incorporation of tritiated thymidine and appears to be closely related to the phenomenon of repair replication in bacteria and mammalian cells. The effect was induced and observed in the extended interphase polytene chromosomes at highly localized single spots distributed randomly throughout the euchromatic chromosome region. (H.L.W.)

57952 (LBL-28) HEAVY-ION-INDUCED SINGLE- AND DOUBLE-STRAND BREAKS IN ϕX-174 REPLICATIVE FORM DNA. Christensen, Ralph Chresten (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1971. Contract W-7405-eng-48. 106p. Dep. NTIS.

Radiation damage in ϕX-174 Replicative Form I (RF I) DNA was measured as a function of linear energy transfer (LET), using radiation qualities ranging from that of ^{60}Co gamma rays to that of highly stripped argon nuclei of average initial charge +16.5 and maximum energy 7.4 MeV/nucleon. Irradiations were performed at room temperature in a highly radioprotective broth (4% Difco Nutrient Broth, 2% AET, 0.01 M Tris, pH 8.0) to minimize free radical effects. With the exception of deuterons, all ion beams terminated in the continuously mixed samples. Samples were assayed for relative proportions of RF I (supercoil), RF II (open coil), and RF III (linear) DNA configurations, using neutral sucrose gradient sedimentation of tritiated thymidine-labeled ϕX-174 RF DNA. Viability of bulk and gradient-separated samples was determined using a spheroplast assay. Total viability radiosensitivity of irradiated samples remained approximately constant over nearly the entire LET range investigated. RF I and RF II specific viability radiosensitivity measures (indices of non-break lethal damage and non-break lethal damage plus single-strand break lethal damage, respectively) dropped slowly with increasing LET, but accounted for 50% or more of lethal events at all LETs. The single-strand break event radiosensitivity also decreased slowly with increasing LET, ranging from 0.34 ± 0.04 break events/Mrad/10^6 daltons for ^{60}Co gamma ray irradiation, to 0.12 ± 0.01 break events/Mrad/10^6 daltons for argon nuclei of average LET 2.4 × 10^4 MeV-cm^2/g. Low-LET alkaline sucrose gradient configurational determinations of total radiation-induced DNA break events yielded consistently greater values, indicating the possible presence of alkali-labile bonds in damaged DNA. At low LET, double-strand DNA breaks were produced at a rate of 0.013 ± 0.003 breaks/Mrad/10^6 daltons, rising to a maximum rate of 0.061 ± 0.008 breaks/Mrad/10^6 daltons at about 5500 MeV-cm^2/g. Double-strand DNA breaks, which are lethal in this biological system, accounted for less than 10% of the total lethality at low LET, rising to 30 to 50% of the total lethality at high LET. (auth)

57953 EFFECTS OF LOW FREQUENCY VIBRATIONAL STRESS ON THE GENOME OF DROSOPHILA MELANOGASTER. Saitta, Frank P. Providence; Univ. of Rhode Island (1970). 89p. University Microfilms Order No. 71-12,802.

Thesis.

The genetic effects of low frequency vibrational stress on Drosophila melanogaster (the fruit fly) were investigated through an analysis of the incidence of dominant lethal, recessive lethal and multigenic mutations. Increases in dominant lethals were observed when males were vibrated at 100 Hz, amplitude 0.5″ (510 g's). The intensity of this effect seemed to be a function of the duration of the treatment. Likewise, subvital and polygenic mutation effects were significantly greater in treated groups than in controls. Experiments were also carried out in an attempt to ascertain the possible mutagenic interaction of gamma irradiation and vibration. The data indicates an antagonistic relationship, i.e., sex-linked lethals and somatic effects were less pronounced in progeny of flies that were irradiated (4000 R) and vibrated (100 Hz; amplitude 0.5″) than in progeny of flies subjected to the 4000 R of irradiation only. Physiological responses, via increased mating activity, were also found to be stimulated in males by vibrational stress. (Diss. Abstr.)

57954 PHOTOREACTIVATION OF MUTATIONAL DAMAGE PRODUCED BY THE INTERACTION BETWEEN DEB AND UV IN NEUROSPORA. Rannug, J. Ulf (Dept. of Genetics, Edinburgh). Mol. Gen. Genet.; 111: No. 2, 194-6(1971).

The mutational damage produced by the interaction between DEB-pretreatment and uv-posttreatment in a Neurospora strain, ad-3A (38701) inos (37401), is photoreactivable. It may thus be concluded that the interaction mutants possess characteristics of uv-induced ones. (auth)

57955 GENETIC REPAIR AND THE SYNTHESIS OF NITRATE REDUCTASE IN USTILAGO MAYDIS AFTER UV IRRADIATION. Resnick, Michael A.; Holliday, Robin (National Inst. for Medical Research, London). Mol. Gen. Genet.; 111: No. 2, 171-84 (1971).

The ability of uv-sensitive (uvs$^-$) and wild type (uvs$^+$) strains of Ustilago maydis to synthesize the inducible enzyme nitrate reductase (NR) was examined following uv-exposure. Low doses of uv-irradiation prior to induction inhibit to a greater degree the first appearance of NR in uvs$^-$ as compared to uvs$^+$ strains; in addition, the exponentially increasing rates of NR synthesis are much less in the uvs$^-$ strains. It is concluded that the damage is primarily pyrimidine dimers in the DNA, since the uv-induced effects are largely removed by photoreactivation. At all but the lowest dose, at least one dimer on the average appears to be induced per functional strand of the nitrate reductase gene. If cells are irradiated after being suspended in NR inducing medium, enzyme synthesis is temporarily stopped or considerably reduced indicating that the mRNA has a short half-life and that transcription is inhibited. However, it resumes within 20 min after exposure which suggests that alteration or removal of damage is very rapid. Unrepaired or improperly repaired dimer regions lead to the production of altered enzyme as shown by the presence of enzyme cross reacting material and the heat lability of NR in crude cell extracts. It is proposed that the synthesis of altered enzyme may be due in part to transcription past unrepaired or improperly repaired dimer regions in the nitrate reductase gene. (auth)

57956 CONJUGAL TRANSFER OF UV-DAMAGED F-PRIME SEX FACTORS AND INDIRECT INDUCTION OF PROPHAGE λ. George, Jacqueline; Devoret, Raymond (CNRS, Gif-sur-Yvette, France). Mol. Gen. Genet.; 111 No. 2, 103-19(1971).

Conjugal transfer of uv-damaged F-prime sex factors was investigated in connection with indirect induction. Using donors and recipients of different ability to perform pyrimidine dimer excision and/or recombination repair, it was found that: Transfer of uv-irradiated F-prime DNA to the recipient cell is unaffected by the presence of pyrimidine dimers. The efficiency of transfer does not decrease even at rather high UV doses given to the donor in which, as a result of irradiation, chromosome replication is strongly inhibited. Transfer of the signal responsible for indirect uv induction can be correlated with the transmission of the uv-damaged sex factor from donor to recipient. In the recipient cell, the sex factor DNA does not undergo excision repair but can be repaired by recombination. It is inferred that the transferred DNA structure is not fully double-stranded. In conclusion, indirect uv induction occurs in a λ-lysogenic recipient upon transmission of a uv damaged replicon which carries stabilized lesions as a consequence of its conjugal transfer. (auth)

57957 X RAY-INDUCED MUTATIONS OF THE GENETICALLY-DETERMINED MELANOMA SYSTEM OF XIPHOPHORIN FISH. Anders, Annerose; Anders, F.; Pursglove, Diana L. (Justus-Liebig Univ., Giessen, Ger.). Experientia; 27: No. 8, 931-2 (15 Aug 1971).

Several crosses were made between irradiated and nonirradiated fish and variations in the macromelanophore gene expression in the offspring are tabulated. Results indicated that the increase in macromelanophore gene expression was due to mutations in a very large number of widely distributed chromosomal genes. The genotypes resulting from the crosses revealed a synergistic effect of x irradiation and hybridization on the increase of macromelanophore gene expression. (H.L.W.)

57958 KINETICS OF REJOINING OF SINGLE-STRAND BREAKS INDUCED BY IONIZING RADIATION IN DNA OF HUMAN LYMPHOCYTES. Donlon, Terrence Edward. Los Angeles; Univ. of California (1971). 47p. University Microfilms Order No. 71-21,325.

Thesis.

The kinetics of repair of single-strand breaks induced by 6 MeV electrons in DNA of human lymphocytes was studied using sedimentation-velocity analysis of molecular weights. The rate of repair was found to be rapid initially and essentially constant for the first 20 to 30 minutes of incubation at 37°C; it then declined markedly. For the rapid initial process the activation energy over the temperature range of 22 to 37°C was 19.1 ± 0.4 Kcal/mole, the temperature at maximum rate was about 40°C, and the Michaelis-Menton constant, estimated from the rate at $V_{max}/2$, was approximately 20 Krads. These results are similar to those characterizing the rate-limiting step for unscheduled DNA synthesis stimulated by x-rays. Moreover, the number of breaks per rad and the maximum rate of incorporation of nucleotides per cell found in this study are similar respectively to the number of lesions per rad and the maximum rate of incorporation of nucleotides per cell found in studies of unscheduled DNA synthesis. It seems likely, therefore, that the repair of single-strand breaks and the incorporation of nucleotides in unscheduled DNA synthesis share the same rate-limiting enzymatic step. (Diss. Abstr.)

57959 EFFECT OF OXYGEN ON SOMATIC CROSSING OVER IN THE X-CHROMOSOME OF DROSOPHILA MELANOGASTER. Stauffer, Henry Hans. Berkeley, Calif.; Univ. of California (1970). 271p. University Microfilms Order No. 71-20,914.

Thesis.

The influence of oxygen on the frequency of somatic crossing over in the X-chromosome of Drosophila melanogaster was studied under a variety of experimental conditions. A series of experiments was carried out under standard conditions, in air and at a temperature of 25°C, spaced at intervals over a period of eighteen months. D. melanogaster was found to be capable of tolerating a wide range of oxygen levels, developing in an apparently normal manner, from zygote to adult, in atmospheres containing as low a concentration of oxygen as seven and a half percent or one as high as ninety percent. Flies raised in seventy to ninety percent oxygen were noted to have significantly more mosaic spots than those which developed in air, thus showing that oxygen by itself can increase the rate of somatic recombination. First instar larvae of the two genotypes were irradiated with 1326 R (at a dose rate of 102 R per minute) in gas mixtures, of air and nitrogen or air and oxygen, whose oxygen content ranged from complete anoxia to one hundred percent. A rapid rise in the number of mosaic spots between the larvae x-rayed in nitrogen and those treated in air was observed. At higher oxygen tensions there occurred a flattening of the response curve. These findings demonstrate the existence of an oxygen effect for somatic recombination in the cells which form the abdominal tergites of D. melanogaster. The relative frequencies of the types of mosaic spots were unchanged by life-long exposures to concentrations of oxygen greater than that of air but were altered by the x-ray treatments, with an increase in the percentages of twin and yellow-singed spots in the trans and cis genotypes, respectively, being found. The data suggest that there may be basic differences between oxygen and x-rays with respect to the mechanisms by which somatic recombination is produced. X-raying first-instar larvae, with the mutant genes in the trans position, in air or oxygen and then post-treating with nitrogen created a substantially higher number of mosaic spots than were found when larvae, after being similarly irradiated, were placed into air or oxygen. This result perhaps is caused by the disruption of an oxygen dependent repair process. (Diss. Abstr.)

57960 NEUTRON-INDUCED MUTANTS OF PISUM SATIVUM AND THEIR COMPARISON WITH X-RAY-INDUCED GENOTYPES. Gottschalk, W.; Chen, R. (Univ., Bonn). Angew. Bot.; 154: 325-42(1970). (In German).

One hundred and sixty-one mutants of Pisum sativum were selected after irradiation of dry seeds with neutrons. The following results were obtained: The chimerical nature of the M_1 plants already known from x-ray treatment was confirmed after neutron irradiation. The proportion of lethal mutants was considerably lower following neutron treatment than with x-rays. Only 14% of all neutron-induced mutants were lethals, while the corresponding proportion in our x-ray experiments was 27%. In the same trial some genes mutated several times; futhermore, at least 11 neutron-induced mutants were identical with genotypes obtained by x-ray irradiation. It can be concluded, that many genes of the Pisum genome show the same response to the action of neutrons and x-rays. The seed production of the fertile mutants varied between 200 and 10% of the original line. Some mutants with a high seed yield could be of interest for mutation breeding. (INIS)

57961 EFFECT OF RADIATION ON SMALL COMPETING POPULATIONS OF DROSOPHILA MELANOGASTER. IV. CHANGES IN LONGEVITY. Dyer, K. F. (Medical Research Council, Harwell, Eng.); Lamb, Marion J. Genetics; 68: No. 4, 559-69(Aug 1971).

Two populations, one of which was homozygous for the marker gene light and the other for the marker gene straw but which was otherwise genetically almost identical, were allowed to compete in the same population cages for 25 successive generations. Twenty-five males and 25 virgin females of each phenotype were used as parents for each generation and at the beginning of each generation the straw parents were irradiated with 1500 R x rays. The longevities of virgin females from the light and straw populations and the heterozygotes between them were measured and compared. Comparisons were also made with the lifespans of females from control cages in which neither population had received any irradiation. The lifespans of all three genotypes from the cages in which the straw population was irradiated were consistently less than those of the corresponding genotypes from the control cages. This difference was thought to be due to the reduction in larval density caused by the induction of dominant lethals in the irradiated straw population since larval density and adult longevity are known to be positively correlated. When allowance was made for this indirect effect of irradiation it was concluded that, although the level of genetic damage in the irradiated population was high, the direct effect of this on longevity was very small. At generation 12 the mean lifespan of flies from the irradiated straw population was only about 5% less than that of the controls and this percentage did not increase in subsequent generations. Prior to generation 12 there was some evidence of a slight increase in lifespan in the irradiated straw population. These small changes in longevity paralleled the changes found in pre-adult competitive ability. (auth)

57962 GENE AND CHROMOSOMAL BEHAVIOR IN A PARASITIC WASP. Leach, Peggy Ann. Orono, Maine; Univ. of Maine (1970). 102p. University Microfilms Order No. 71-20,270.

Thesis.

A study was made of two forms of Muscidifurax raptor (Girault and Sanders), one reproducing by male parthenogenesis (arrhenotoky) the other by female parthenogenesis (thelytoky). In the thelytokous form, meiosis is entirely normal, n = 5. Diploid restoration (2n = 10) occurs by endomitosis during the first cleavage division. Thus, females are homozygous for each locus. This cytological demonstration of female homozygosity is supported by x-ray studies in which all visible mutants appeared in the immedi-

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ate progeny of irradiated females. To determine the applicability of the Habrobracon scheme of sex determination to Muscidifurax, matings were made within the arrhenotokous stock of red-eyed females and black-eyed males. The progeny were examined for black-eyed, biparental males, none of which was found. A comparative study of the effects of x rays on arrhenotokous virgin female production and thelytokous female production was performed, using dosages ranging from 1000 to 9000 R. Correlations and regressions were done on both sets of data. Regression coefficients of the two lines proved to be homogeneous; thus, the two types of experimental animals were behaving in the same manner to the x rays. When comparisons were made point-for-point, it was found that the x rays reduced progeny production to a significantly larger degree in the arrhenotokous form than in the thelytokous form. The difference could be explained on the basis of differential behavior, lethal versus non-lethal, of minor, terminal deletions. Seven gynandromorphs, each with male antennae and an ovipositor, appeared during this study. Four were progeny of irradiated virgin females from arrhenotokous stock and would not be expected to show female structures. Their presence can be explained by endomitotic diploidization of posterior cleavage nuclei subsequent to cleavage I. It was suggested that these gynandromorphs may demonstrate a close relationship between the arrhenotokous and the thelytokous form of reproduction in this wasp. (Diss. Abstr.)

57963 RADIATION AND CHROMOSOMAL ABNORMALITY. **Sugahara, Tsutomu (Kyoto Univ.). Rinsho Kagaku; 6: No. 5, 611-15(May 1970). (In Japanese).**

In the study of chromosomal abnormalities produced by ionizing radiation, human peripheral lymphocytes are used. The methods of observation, kinds of abnormalities observed, exposure dose, and mechanism of lymphocyte turnover are discussed. The abnormality in incubated peripheral lymphocytes produced by radiation is an unstable type of aberration, but there are still unsolved problems such as the increase in heteroploidy and the variation in chromosomal aberrations after irradiation of the human body. Unstable types of abnormality were seen in peripheral lymphocytes following exposures to a low dose, internal exposure, and atomic bomb radiation in Japan and the Bikini atoll. These can be examined and detected over a long period of time. Chromosomal aberration can be used as a means for evaluating biological doses, and could offer a clue to the life span and turnover of lymphocytes, but the phenomenon of chromosomal aberration has not yet been elucidated in detail. (Japan)

57964 EFFECT OF HYGROMYCIN B AND STREPTOMYCIN ON ACTINOMYCES HYGROSCOPICUS VARIABILITY INDUCED BY X-IRRADIATION. **Tsyganov, V. A.; Pronina, M. I.; Kvitko, K. V. (Research Inst. of Antibiotics, Leningrad. Univ. of Leningrad). Genetika; 7: No. 9, 160-8(Sep 1971). (In Russian).**

Effects of hygromycin B and streptomycin on x ray induced variability of Actinomyces hygroscopicus strains differing in their resistance to hygromycin B were studied. It was shown that irradiation at a 60 kR dose of strains 33-a and 5096 revealed higher or equal viability of spores as compared to that of original strain 33. Over the range of 320 to 840 kR, the cultures adapted to hygromycin B proved to be more resistant to the lethal effect of the antibiotics studied on radioresistance of Act. hygroscopicus. The higher the resistance of the actinomycete to hygromycin B, the lower was variability of radioresistance. It was noted that the process of mutation in Act. hygroscopicus, induced by x irradiation, was modified by antibiotics including hygromycin B produced by the given culture. An increase of mutation rate was observed in sensitive strain 33 when its irradiated cells were grown in a medium containing a non-lethal concentration of hygromycin B. Strain 33-a, possessing a moderate resistance to hygromycin B, occupied an intermediate position as concerned the degree of modification of the mutation process under the action of antibiotics mentioned. Highly resistant strain 5096 did not reveal an essential increase of the rate of morphological mutations. When Act. hygroscopicus was grown in a medium containing a non-lethal dose of streptomycin, a protective effect was noted expressed in a marked decrease of the rate of x-ray-induced morphological mutations in Act. hygroscopicus. (auth)

57965 INFLUENCE OF 5-BROMOURACIL ON THE SENSITIVITY OF Her$^+$- AND Her$^-$- BACTERIA TO THE LETHAL AND MUTAGENIC EFFECT OF UV-LIGHT. **Kondrat'ev, Yu. S.; Skavronskaya, A. G. (Inst. of Epidemiology and Microbiology, Moscow). Genetika; 7: No. 9, 149-54(Sep 1971). (In Russian).**

The effect of substitution of thymine on 5-bromouracil (5-BU) in DNA of Hcr$^+$ and Hcr$^-$ cells on their uv-sensitivity was studied. It was found that 5-BU-substitution sensitized the strains having equal level of thymine requirement to the lethal action of uv-light to the same extent irrespective of their hcr genotype. The effect of this sensitization was probably due to the disturbance in the repair of single-strand breaks. Such breaks may appear as a result of the direct action of uv-light on 5-BU-containing DNA or may be a consequence of the action of repair enzymes. Incorporation of 5-BU into the bacterial DNA leads to the enhanced frequency of direct mutations and reversions induced by uv irradiation. The enhanced frequency of uv-induced mutations in 5-BU-substituted bacteria appears to be a result of errors during repair and/or semiconservative replication of DNA containing nonexcisible photoproducts of 5-BU. As in the case of killing, the sensitization to the mutagenic action of uv light is not related to hcr genotype. The lower sensitizing effect of 5-BU substitution on the mutagenic action of uv light as compared with the sensitizing effect on the lethal action seems to be due to different mechanisms of uv-induced death and mutagenesis in 5-BU-substituted cells. (auth)

57966 STUDY OF COMPETITIVE CAPACITY OF DROSOPHILA MELANOGASTER INDIVIDUALS HETEROZYGOUS FOR X-RAY INDUCED MUTATIONS. **Lur'e, T. L.; Gol'zberg, K. L.; Vorobtsova, I. E. (Central Research Inst. of Roentgenology and Radiology, Leningrad). Genetika; 7: No. 9, 84-9(Sep 1971). (In Russian).**

It was observed that larvae of Drosophila melanogaster heterozygous for x-ray induced mutations competed for food less successfully than larvae of normal flies. This conclusion was inferred from a more intense elimination of test-line larvae as compared to those of the control normal line in mixed cultures. It was established, however, that in pure cultures the survival in comparable groups depended on the density of the larval population. When the larval population was sparse, heterozygous individuals survived better than the control wild-type population, and vice versa in cases of a high density of the larval population. Apparently this is associated with the different character of distribution for viability of individuals of comparable groups. (auth)

57967 MUTAGENIC EFFECTS OF DIFFERENT TYPES OF RADIATION ON GERM CELLS OF MALE MICE. VI. GENETIC RADIOSENSITIVITY OF GERM CELLS IN EMBRYOS AND NEWBORNS. **Fazylov, U. T.; Pomerantseva, M. D. (Inst. of General Genetics, Moscow). Genetika; 7: No. 9, 68-75(Sep 1971). (In Russian).**

The frequency of reciprocal translocations and dominant lethal mutations were used as indices of radiosensitivity. The dose-effect dependence for the yield of reciprocal translocations in germ cells of newborn and spermatogonia of adult mice was shown to be linear within the range of 20 to 400 R doses of x rays. Genetic radiosensitivity of gonocytes of newborns was one third of that of spermatogonia. The frequency of reciprocal translocations in males developed from embryos subjected to x irradiation at a 20 R dose was higher than that in adult mice irradiated at the same dose. In cases of irradiation of embryos at doses of 50 and 100 R, the translocation yield was lower than in adult mice irradiated at the same doses and was similar to the mutation rate in newborns. The study of dominant lethal mutation rate in germ cells of male mice irradiated at different ages did not reveal any difference in their genetic radiosensitivity. The lower frequency of translocations in germ cells of embryos and newborn male mice at 50 R and higher doses is probably due to a higher selective death-rate of primary germ cells. (auth)

57968 DIFFERENCES IN RADIATION-INDUCED LESIONS OF CHROMOSOMES OF THE EMBRYONIC MERISTEM OF CREPIS CAPILLARIS SEEDS. **Nemtseva, L. S.; Romanov, V. P. (Inst. of General Genetics, Moscow). Genetika; 7: No. 9, 42-50(Sep 1971). (In Russian).**

The frequency of chromosome aberrations induced by x- and gamma irradiation in air-dry (water content about 7%) and dry (water content about 4%) seeds of Crepis capillaris was the highest in cells that were the first to enter mitosis and much lower in those that were the last to proceed to mitosis. This difference was the most conspicuous in the population of embryonic cells derived from one seed. The difference between cells derived from different seeds but not different in the time of the onset of mitosis proved to be slight. As the result of treatment of super-dry seeds (water content about 1%) with sparsely ionizing radiation, the frequency of induced chromosome aberrations was the same in all the cells irrespective of the time of the mitosis onset. As a result of the treatment of dry (water content about 4%) seeds with fast neutrons, the frequency of chromosome aberrations was different in cells that proceeded to mitosis at different times, but the character of this dependence was not the same as in the case of sparsely ionizing irradiation of dry seeds. These arrangements were observed both in cells that were first and those that were last to proceed to mitosis, while the lowest frequency was observed in cells with the intermediate time of mitosis onset. (auth)

57969 RADIATION RESISTANCE IN PLANTS CULTIVATED AT HIGH ALTITUDES. **Nuzhdin, N. I.; Pastushenko-Strelets,**

N. A. (Inst. of Biological Physics, Moscow). Dokl. Akad. Nauk SSSR; 197: No. 4, 954-7(1 Apr 1971). (In Russian).

Barley seeds from plants grown in the regions near Moscow, Tallin, Tartu, and the Pamirs were irradiated with ^{137}Cs gamma radiation (10 Ci). Radiosensitivity of the seed could not be correlated with moisture content in the seed. However chromosomal damage was least in the case of the Pamir-grown seed, and greatest for the seed from the Tallin area, indicating that a distinct increase in radioresistance was inherent in barley seed grown under conditions of high altitudes. Cytological analysis was also conducted on barley seed that was obtained from plants grown in the absence of the uv portion of the spectrum. The results indicated that the frequency of chromosomal aberrations in such seed after γ irradiation was significantly higher than in irradiated controls (seed grown under light conditions normal to the western Pamirs). (K.S.W.)

57970 LIMITED CONTRIBUTION OF DNA REPAIR IN THE RECOVERY OF CHROMOSOMES FOLLOWING IONIZING RADIATION. Mikhel'son, V. M. (Inst. of Cytology, Leningrad). Tsitologiya; 13: No. 8, 932-45(Aug 1971). (In Russian).

According to the author's hypothesis, the metazoan chromosomes possess a lowered, if any, reparative capacity following treatment with ionizing radiation, since the latter extends its damaging effect to involve not only the chromosomal DNA, whose reparation is possible, but also some interreplicon links of different chemical nature, whose reparation is impossible or difficult. UV rays cause the damage of DNA only, therefore the injuries of that kind are reversible. Genetical structures in bacteria involve only one replicon, and thus the reparation of bacterial DNA is, at the same time, the recovery of the whole genetic apparatus of the cell. (auth)

57971 INDUCTION OF MUTATIONS IN BACTERIOPHAGE ΦX174 BY IONIZING RADIATION. Bleichrodt, J. F.; Berends-Van Abkoude, E. R.; Verheij, W. S. D. (TNO, Rijswijk, Netherlands). Kon. Ned. Akad. Wetensch., Proc., Ser. C; 74: 172-82 (1971).

Irradiation of suspensions of the amber mutants am9 and am14 of bacteriophage ΦX174 in nutrient broth or thiourea solutions by X- or γ-rays induces virus particles able to propagate on a suppressorless host. The efficiency of induction of revertants amounts to about 6×10^{-7} per lethal hit, both for irradiations in an oxygen and in a nitrogen atmosphere. For unknown reasons the induction under nitrogen increases sometimes with radiation dose. (auth)

57972 CHROMOSOME ABERRATIONS IN PERSONS EXPOSED CHRONICALLY TO IONIZING RADIATIONS. Deknudt, Gh.; Leonard, A.; Leonard, E. D. (CEN–SCK, Mol, Belgium). Genen Phaenen; 14: No. 2, 46(Apr 1971).

Studies were made on radiotherapy physicians occupationally exposed for a period of 3 to 30 years. Relationships between levels of chromosome aberrations, duration of exposure, and dose rates were observed. It is pointed out that interpretation of results is very difficult due to low dose rates, dose fractionation, different sources of radiation, and other factors. (H.L.W.)

57973 IN VITRO CHROMOSOMAL RADIOSENSITIVITY IN FANCONI'S ANEMIA. Higurashi, Makoto; Conen, Patrick E. (Univ. of Toronto). Blood; 38: No. 3, 336-42(Sep 1971).

Peripheral blood samples and skin fibroblast cultures from five children with Fanconi's anemia and four normal children were irradiated with 10 and 100 rads. Nonirradiated duplicate cultures were used as controls. Blood cultures were harvested after 52 and 72 hr of incubation and fibroblast cultures were harvested 24 hr after irradiation. The frequency of chromosomal breakage caused by irradiation was calculated by subtracting figures for nonirradiated samples from those for irradiated samples. After irradiation, the number of breaks/cell/rad in samples from Fanconi's anemia was approximately fourfold greater in lymphocytes and twofold greater in fibroblasts than in the controls. The number of dicentrics and rings per cell in cultured lymphocytes after 100 rads was significantly greater in the Fanconi's anemia samples than controls. Therefore, in vitro, chromosomes of cells from children with Fanconi's anemia were significantly more radiosensitive than those of controls ($p < 0.01$). (auth)

57974 MODIFICATION OF X-RAY RADIATION EFFECTS BY MEANS OF CHEMICAL SUBSTANCES. Langer, I. Genet. Slechteni; 42: No. 5, 17-22(1969). (In Czech).

The influence of cystein, urea and thiourea on the radio-sensitivity and mutability of spring barley, variety "Valtický", was studied. The seeds were steeped in a solution of the mentioned substances and then radiated with x-rays in doses of 100 R, 2500 R and 4000 R. The greatest protective effect in the M_1 generation was provided by urea, especially at higher doses of radiation. The sterility of the ears in the M_1 generation after the application of the protective substances in combination with lower radiation doses was greater than in control specimens subjected to radiation without protective substances. In combination with higher doses of radiation the sterility of the ears of the M_1 generation was the same as that of the control specimen. All the substances used lowered the frequency of chlorophyl mutation in the M_2 generation per 100 ears of M_1 and the frequency of chlorophyl mutation per 100 plants of M_2. (auth)

57975 CYTOGENETICS OF ZESTE EXPRESSION IN DROSOPHILA MELANOGASTER. Gelbart, William Martin. Madison, Wis.; Univ. of Wisconsin (1971). 110p. University Microfilms Order No. 71-16,868.

Thesis.

Rearrangements were employed to investigate the nature of the zeste-white relationship. X-ray induced dominant suppressors of zeste were recovered from three sorts of treated chromosomes: structurally normal z w^+ chromosomes, chromosomes deficient for zeste which were genetically Df(1) z w^+, and chromosomes duplicate in tandem for all or a portion of w^+ and which were designated z w^+ w^+. Genetical and cytological analysis of each of the 57 recovered suppressor strains was performed to localize the site of the suppressor mutation. As had previously been demonstrated by Gans, the only X chromosome loci implicated in the control of zeste expression are zeste and white. In addition, several dominant autosomal suppressors of zeste were isolated. At least three separate autosomal loci function in the promotion of the zeste phenotype. All w^+ alleles contained in tandem duplications and triplications of this locus are competent in promoting zeste expression. In contrast, insertional duplications of w^+ that do not include the z locus within the duplicated segment are incapable of promoting zeste coloration. Moreover, these insertions actually inhibit the zeste-expressing activity of functional w^+ alleles in the same nucleus. These differential responses of w^+ in promoting zeste expression, which depend upon the chromosomal location of w^+, can be termed an S-type position effect on w^+. A model describing these data as reflections of transcriptional control of the z-w system is detailed. In essence, the model suggests that in nuclei in which these genes are to function, the zeste, white, and autosomal Suppressor of zeste (Su(A)z) loci are brought into close physical proximity by a process akin to ectopic pairing. Polarized transcription from white, through Su(A)z and finally through zeste then occurs. This model is consistent with several peculiarities associated with the white locus and is applicable to other S-type position effect systems. The implications of this model for chromosomal regulation are discussed. As a secondary study, a fine structure analysis of zeste was undertaken. Among a small sample of spontaneous and EMS induced zeste mutants, three types of z allele were found. Heterozygotes for z^1 and each of these alleles are mutant. Homozygotes (females) for the first group (two alleles) have yellow eyes, while homozygotes for the second class (six mutants) are wild-type in eye color, and homozygotes for the third group (one mutant) have mottled brown eyes. Hemizygotes (males) for each of these alleles are wild-type. Among this small sample of z mutations, no intragenic complementation was noted. Attempts to spatially separate the one allele in the third group (z^{p69a}, peppered-69a) from seven other z mutants were unsuccessful. The maximum distance between z^{p69a} and any of these other alleles is 0.01 map units. (Diss. Abstr.)

57976 GENETIC CONTROL OF MUTATION INDUCTION IN SACCHAROMYCES CEREVISIAE. Lemontt, Jeffrey Fielding. Berkeley, Calif.; Univ. of California (1970). 136p. University Microfilms Order No. 71-20,843.

Thesis.

Twenty mutants of Saccharomyces cerevisiae were selected for reduced ultraviolet light (UV)-mutability as measured by locus reversion of the highly UV-revertible ochre-suppressible arg4-17 allele. These mutants represent only three unlinked recessive loci denoted by rev1, rev2, and rev3. The rev2 locus is on chromosome XII at a distance of 4.0 centimorgans distal to asp5. Neither rev1 nor rev3 is centromere-linked. Strains carrying rev1-1, rev2-1 and rev3-1 are moderately UV-sensitive with Dose Reduction Factors (DRF) of 3.7, 4.3, and 8.5 in the respective haploids and 2 in the three homozygous rev diploids compared to wild-type; rev1-1, rev2-1 and rev3-1 also confer X-ray sensitivity (DRF's of 2.4, 1.5, and 1.8 at 10% survival in respective homozygous rev diploids) and ethylmethanesulfonate (EMS)-sensitivity (DRF's at 1% survival of 1.1, 2.7, and 2.7 in respective rev haploids). Mutation induction controlled by a small number of genes is thought to be related to the repair of lethal DNA damage. UV-induced locus reversion of arg4-17 is reduced from the wild-type level about 35-fold at 265 erg/mm^2 in rev1-1 and rev3-1 strains, while in rev2-1 strains it is only reduced about 3.5-fold. At the same dose in the same strains, UV-induced locus reversion of the ochre-suppresible lys1-1 allele is also severely reduced in

XUM

the rev1-1 and rev3-1 strains (about 10 times), but to a lesser degree in the rev2-1 strain (two-fold). UV-induced reversion of arg4-6 is also reduced by rev1-1 and rev3-1 (about 5 times), but doubled by rev2-1. At lower UV doses rev2-1 exerts no effect. The average frequency of UV-induced forward mutation to ade1 or ade2 in all rev strains is reduced almost four-fold, while the frequencies of mutation induced by EMS are between two and three times greater in rev strains than in wild-type. UV-induction of respiratory deficiency in rev3-1 strains was between three and seven times the frequencies observed in wild-type strains, in rev2-1 strains it was reduced, and in rev1-1 strains it was unaffected. The rev1 and rev3 genes are thought to have a nonspecific action in reducing UV-mutation, while rev2 may be specific for reversion of nonsense alleles. Strains carrying two or more UV-sensitive genes were constructed. The UV-survival and UV-reversion phenotypes of multiple rev haploid strains indicate that REV genes do not act in a single linear pathway. The phenotypes of double mutants of rev and uvs9 suggest that REV pathways are not blocked by uvs9, but rather act on intermediates in DNA repair, one of which is produced earlier by the UVS9 pathway. The results of this study are consistent with a model already proposed for UV-mutagenesis in E. coli. The similarities and differences of rev mutants in yeast to exr and rec mutants in bacteria are discussed. (Diss. Abstr.)

57977 SPONTANEOUS SOMATIC RECOMBINATIONS IN A NICOTIANA XANTHI n.c. MUTANT AND THEIR INDUCTION BY GAMMA RADIATION: PRELIMINARY GENETIC STUDIES. Dulieu, Hubert; de Boelpaepe, Robert; Deshayes, Alain (Institut National de Recherches Agronomiques, Dijon, France). Compt. Rend., Ser. D; 272: No. 26, 3287-90(28 Jun 1971). (In French).

A chlorophyll mutation a_1 of intermediate dominance established reciprocal and non reciprocal variations in leaves. Their spontaneous frequency is small, but very much enhanced by gamma radiation. The descendants of these variants indicate that in the absence of reciprocity, the heterozygote sites are subject to conversions. (France)

Health Physics and Safety

Refer also to abstracts 57351 and 58030.

57978 MEDICAL SURVEILLANCE OF WORKERS IN THE STORAGE CENTER FOR RADIOACTIVE WASTE. Bessuges (CEA, La Hague, France. J. Belge Radiol.; 54: No. 1, 101-9 (Jan-Feb 1971). (In French).

Medical problems of workers are discussed, especially for the nuclear center Hague. The center reprocesses irradiated fuel elements from French power reactors. Final deposition of waste products is discussed. Neither excessive irradiation nor internal contamination was observed. The following medical problems were encountered: feelings of claustrophobia and confinement because the worker does not see daylight; respiratory difficulties; irritation of nose, trachea, and sinuses, and conjunctiva because of dry air; excessive heat; disturbances of vision because of insufficient lighting in glove boxes; disturbances of the corporeal image during handling of remote manipulators; difficulties of movement, respiration, and heat exchange due to masks and protective clothing. (H.B.G.)

Radioactive Contamination and Decontamination

Refer also to abstracts 57517, 57574, 57622, 57629, 57773, 57948, 57949, and 58079.

57979 (EUR-4667) RADIOACTIVE CONTAMINATION OF FOODSTUFFS IN COUNTRIES OF THE COMMUNITY IN 1969. (European Communities, Luxembourg. Commission). Jul 1971. 66p. (In several languages). Dep. NTIS (U. S. Sales Only). EUR DM 7,30.

Data are presented on the radioactive contamination of foodstuffs in the EURATOM countries in 1969. The data relate to the radionuclides ^{90}Sr and ^{137}Cs. An estimate is given of the ^{90}Sr intake. For 1969 this intake averaged 3,865 pCi of strontium-90, which corresponds to 14.4 pCi/gCa in the diet. (auth)

57980 (HASL-245) FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, JUNE 1, 1971-SEPTEMBER 1, 1971. Hardy, Edward P. Jr. (New York Operations Office (AEC), N. Y. Health and Safety Lab.), 1 Oct 1971. 254p. Dep. NTIS.

Current data are presented from the HASL Fallout Program, the National Radiation Laboratory in New Zealand, and Radiological Physics Division at Argonne National Laboratory, and the EURATOM Joint Nuclear Research Centre at Ispra, Italy. The initial section consists of data summaries and notes covering the following topics: ^{90}Sr fallout and precipitation by ten degree latitude bands, the stratospheric inventory of ^{238}Pu, and stratospheric inventories of fission produces. Subsequent sections include tabulations of radionuclide levels in surface air, stratospheric air, fallout, milk, and tap water. (53 references) (auth)

57981 (HASL-245(App.)) APPENDIX TO FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, JUNE 1, 1971-SEPTEMBER 1, 1971. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Oct 1971. 429p. Dep. NTIS.

Data are tabulated from fallout monitoring programs carried out from June through September 1971. Results are included from: measurements of ^{89}Sr and ^{90}Sr deposition at various world land sites and Atlantic Ocean weather stations; the content of ^{90}Sr in New York City milk; the content of ^{137}Cs and ^{90}Sr in New York City drinking water; and the content of various radioisotopes in samples of surface atmosphere obtained in North, South, and Central America. (C.H.)

57982 REMOVAL OF ^{60}Co CONTAMINATION FROM THE SKIN. Vorob'ev, A. M. Gig. Sanit.; No. 6, 106-8(Jun 1971). (In Russian).

A method was sought for the decontamination of ^{60}Co from the skin. Cobalt-60 in the form of a dissolved salt was applied to the palm of the hand. The agents were: an economy soap as a control, EDTA, in the form of the sodium salt Trilon B, a mixture of x-aminoacetic acids (Polycomplexon), and the sodium salt of diethylenetriaminepentaacetic acid (DTPA). The decontamination ability of a given agent depended on the physico-chemical state of the Co compound. Simple contact contamination was most easily cleaned off. HCl solutions of Co were more complex. A second contamination of the skin immediately after decontamination brought on the worst situation, because the protective skin oils had been removed. (K.S.W.)

57983 DATA. SECTION I. MILK AND FOOD. Radiol. Health Data; 12: No. 8, 411-20(Aug 1971).

Data are presented on the content of ^{140}Ba, ^{137}Cs, ^{131}I, ^{89}Sr, and ^{90}Sr in milk samples collected from various locations throughout North, South, and Central America during April 1971. (C.H.)

57984 DATA. SECTION III. AIR AND DEPOSITION. Radiol. Health Data; 12: No. 8, 422-6(Aug 1971).

Data are presented on the gross β radioactivity in samples of surface atmosphere and precipitation collected from various locations throughout North, South, and Central America during April 1971. (C.H.)

57985 DATA. SECTION IV. OTHER DATA. Radiol. Health Data; 12: No. 8, 427-38(Aug 1971).

Data are presented on the levels of radioactivity in the environment of the environs of Oak Ridge, Tennessee and Aiken, South Carolina during the last half of 1969. (C.H.)

57986 CONTAMINATION OF SOILS AND PLANTS WITH ^{90}Sr AS CONSEQUENCE OF NUCLEAR WEAPONS TESTS DURING THE PERIOD 1960 THROUGH 1963. Fiedler, H. J.; Reissig, H. (Technische Univ., Dresden). Biol. Rundsch.; 3: No. 4, 149-68(1965). (In German).

For the period 1960 to 1963, ^{90}Sr contamination of soil and agriculturally important plants was studied for the DDR and compared with international data. An increase in ^{90}Sr content of soil showed a correlation with fallout from nuclear weapons tests. Differences between various regions resulted from variation in rainfall. ^{90}Sr contamination of plants increased from 1961 through 1963 in good agreement with international data. Plants such as potatoes and cabbage, which are not too sensitive to surface contamination, showed a lesser increase in radioactivity than grass and grain. (H.B.G.)

57987 TRACE ELEMENT CONTENTS AND NATURAL RADIOACTIVITY OF FOODS IN SOME DISTRICTS OF KIEV REGION. Barannik, P. I.; Mikhalyuk, I. A.; Motuzkov, I. N.; Yatsula, G. S. (Kiev Medical Inst.). Vop. Pitan.; 29: No. 1, 79-81(1970). (In Russian).

Mean values with SEM are tabulated for Ni, V, Ba, Cr and Mn contents and natural radioactivity of samples of wheat, millet, maize, sunflower seeds, beans, potato, red beet, cabbage, onion, garlic, radish, apple, pear and plum from districts free from endemic goitre (4-18 samples of each item) and districts affected by endemic goitre (4-29 samples). Highest contents were: Ni, cereals and beans; V, beans, vegetables; Ba, cereals, some vegetables; Cr, beans, garlic, onion; Mn, beans, cereals, some vegetables. In general, contents of Ni, V, Ba and Cr were higher in the districts affected by goitre. Radioactivity was mostly due to ^{40}K naturally present; it was highest in beans and sunflower seeds. (EURATOM)

57988 RADIOACTIVITY OF FOODSTUFFS IN 1970. Miserez, A. (Service Federal de l'Hygiene Publique, Bern). Mitt. Geb. Lebensmittelunters. Hyg.; 61: No. 2, 165-92(1971). (In French).

The present level of radioactivity in the food supply in Switzerland does not present any danger to the human population. The average content of ^{90}Sr in milk is 12 pCi/liter, the same as it was in 1969. The uptake of ^{90}Sr through foods amounts to approximately 18 pCi/person/day; whereas it was as high as 100 pCi in 1964. The Chinese nuclear explosion in September 1969 and the French nuclear tests in 1970 had no significant effect on the radioactivity of foods produced in Switzerland. (H.B.G.)

57989 RADIOACTIVITY OF FOODSTUFFS IN 1969. Miserez, A. (Service Federal de l'Hygiene Publique, Bern). Mitt. Geb. Lebensmittelunters. Hyg.; 61: No. 1, 89-116(1970). (In French).

Radioactive fallout from the Chinese explosions in December 1968 and September 1969 augmented the radioactivity of milk in Switzerland during the vegetative period of grass, especially through an increase in ^{90}Sr. The degree of contamination was relatively slight and presented no danger to the population. Although, after the September explosion, the presence of ^{131}I could be demonstrated in the thyroid glands of dairy cattle, its concentration in milk was too low to be detectable. Altogether, the ^{90}Sr content, which is the main contaminant of foods, decreased somewhat in comparison with 1968. From the average ^{90}Sr content of plain milk, amounting to 12 pCi/liter, the amount of ^{90}Sr taken up by man was 18 pCi/person/day in comparison to 22 pCi in 1968. (H.B.G.)

57990 DATA. SECTION I. MILK AND FOOD. Radiol. Health Data Rep.; 12: No. 7, 371-80(Jul 1971).

Data are presented on the content of ^{140}Ba, ^{137}Cs, ^{131}I, ^{89}Sr, and ^{90}Sr in samples of milk collected from various locations throughout North, Central, and South America during March 1971. (C.H.)

57991 DATA. SECTION II. WATER. Radiol. Health Data Rep.; 12: No. 7, 381-7(Jul 1971).

Data are presented on the gross α and β radioactivity and content of ^{226}Ra, ^{90}Sr, and tritium in samples of drinking water and tritium in samples of surface waters collected throughout the USA during 1970. (C.H.)

57992 DATA. SECTION III. AIR AND DEPOSITION. Radiol. Health Data Rep.; 12: No. 7, 388-92(Jul 1971).

Data are presented on the gross β activity in samples of surface atmosphere and precipitation collected throughout North, Central, and South America during March 1971. (C.H.)

57993 DATA. SECTION IV. OTHER DATA. Radiol. Health Data Rep.; 12: No. 7, 393-404(Jul 1971).

Data are presented on levels of radioactivity in the environment in the vicinity of the Savannah River Plant, Aiken, S. C., during 1970. A list of underground nuclear explosions reported during June 1970 is included. The venting of Baneberry low yield underground nuclear explosion of December 18, 1970, resulted in the release of less than one milliroentgen per hour at offsite locations in the vicinity of the Nevada Test Site. Monitoring activities are described. The data showed that the levels of radioactivity released presented no health hazards to persons living downwind. The exposure of onsite personnel did not exceed the occupational guides set by the Federal Radiation Council. (C.H.)

57994 EXPOSURE OF HUMAN BEINGS TO NATURAL AND ARTIFICIAL SOURCES OF IONIZING RADIATIONS. Rodier, J.; Vernhes, C.; Estournel, R. Maroc Med.; 49: 75-91(Feb 1969). (In French).

Surveyed are both natural and artificial sources of ionizing radiation in relation to man. Included are cosmic radiation of galactic origin, particle radiation from the sun, and radiation within the Van Allen belts. Natural radioactive isotopes, such as ^{3}H, ^{14}C, ^{40}K, ^{87}Rb, ^{232}Th, and ^{238}U, and internal natural sources of radioactivity, such as ^{3}H, ^{14}C, and ^{40}K are discussed. Content of radioactivity is listed for various bodies of water and for different types of foodstuffs. With respect to artificial radiation sources, the following topics are discussed: medical equipment, peaceful uses of nuclear energy, and fallout from test explosions. Results of the survey are compiled in 16 tables. As far as natural radiation sources are concerned, solar radiation represents 50% of total human exposure; then follows cosmic radiation with 30%, and ^{226}Ra deposition in the bone. During solar flares, doses between 30 and 60 rem were measured within 2 to 3 hours at 50 km altitude over France. (H.B.G.)

Dosimetry and Monitoring

Refer also to abstracts 57586, 57714, 57743–57745, 57764, 57767, 57808, 57823, 57833, 57837, 57838, 57840, 57847, 57858, 58075, 58138, 58143, and 59926.

57995 (CONF-711013–1) CHEST CLEARANCE OF INHALED ^{60}Co OXIDE. Brown, P. E.; Gupton, E. D. (Oak Ridge National Lab., Tenn.). [1971]. 9p. Dep. NTIS.

From 17. annual bioassay and analytical chemistry meeting; Boulder, Colo. (13 Oct 1971).

Chest counting data have been collected for about four years for a human case which involved inhalation of ^{60}Co-oxide. The measured chest burden, which decreases with successively increasing half-times (about 10 months at early times to about 60 months after three years), may be calculated almost precisely with an expression related directly to the model of the Task Group on Lung Dynamics. Only the delayed transfer half-time and the long-term fraction retained in pulmonary lymph nodes of the Class Y model need be adjusted to fit this case. With the exception of the long-term fraction in the lymph nodes, only one rate of elimination seems to be present, 225 days, throughout the period of observation. (auth)

57996 (DPSPU–71–30–16) EFFECT OF THE SAVANNAH RIVER PLANT ON ENVIRONMENTAL RADIOACTIVITY. Semiannual Report, January–June 1971. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Plant). Sep 1971. Contract AT(07-2)-1. 13p. Dep. NTIS.

The results of the environmental monitoring program for the atmosphere, vegetation, milk, and water in the vicinity of Aiken, S. C., for the period January 1 through June 30, 1971, are presented. The quantity of radioactive waste released by the Savannah River Plant to its environs was, for the most part, too small to be distinguished from natural background radiation or was obscured by fallout from offsite sources. Beta activity in air, which showed no relationship with plant operations and was due to global fallout, was slightly higher than that observed for the same period of 1970 and there was a two-fold increase over the previous six-month period. Radioactive materials in fish flesh continued to be far below levels considered significant from a health standpoint. The average concentration of any radionuclide in Savannah River water at Highway 301 did not exceed 0.3% of the concentration guide. (auth)

57997 (LBL–314) IN VIVO RADIOBIOLOGICAL STUDIES OF 910 MeV HELIUM ION BEAM. Chong, Claude Y. L. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1971. Contract W-7405-eng-48. 97p. Dep. NTIS.

Thesis.

Both the modified Bragg peak and the plateau portion of the 910 MeV helium ion beam from the Berkeley 184'' synchrocyclotron (henceforth abbreviated as "peak α" and "plateau α" respectively) were compared to cobalt-60 gamma rays (^{60}Co γ) by using 3 modes of total body exposure to evaluate 3 parameters in each of 4 in vivo systems in 13 to 14 week old female LAF$_1$ mice. The 3 modes of exposure were single dose in air, split dose in air, and single dose under hypoxia, and the 3 parameters evaluated included relative biological effectiveness (RBE) in air, recovery pattern in air expressed as percentage of recovery of the first dose (%R), and oxygen enhancement ratio (OER). The 4 test systems consisted of 6-day animal survival, 30-day animal survival, survival of microscopic intestinal colonies, and survival of macroscopic endogenous spleen colony forming units (CFU). Because the survival curves in each set were not parallel, the doses to achieve iso-effect were compared at several survival levels in order to elicit a more composite picture. For lethality studies, besides the more reliable median lethal dose (LD$_{50}$) conventionally used, the 90% and 10% lethal doses (LD$_{90}$ and LD$_{10}$ respectively) were also evaluated. For intestinal colonies, in addition to the slope (inverse of D$_0$) and the "extrapolation number" at zero dose (n), the doses resulting in 100 colonies and 10 colonies were computed. For spleen colonies, similar data were obtained except that the 2 levels of survival selected were 10 colonies and 1 colony. The RBE of peak α was significantly greater than unity for all end points of the 4 systems under consideration. It ranged from 1.17 to 1.39, being greater than 1.25 in most instances. On the other hand, plateau-α RBE was not significantly different from unity, with a mean effectiveness of 1.12. Recovery at 48 hours after exposure was in general greater in the intestines than in hemopoietic tissues. For gut death, it amounted to 51.4 to 67.4%, depending on the survival level and was almost identical for all 3 types of radiation. For marrow death, peak-α irradiated mice showed significantly less capacity for recuperation than those exposed to plateau α or ^{60}Co

XUM

γ, especially at LD$_{90}$ level (16.7 vs 33.6 and 47.5%). For intestinal colonies, again, the 3 types of radiation were comparable, and remarkable recovery of 80.0 to 114.6% was observed. Moreover, all 3 recovery regression lines were less steep than their single dose counterparts, the change in D$_0$ ranging from 50.9 to 66.1%. For spleen colonies, the change in D$_0$ was least with peak α (15.2%) than with plateau α (44.8%) or ^{60}Co γ (50.9%). At 10 colony level, all 3 radiations resulted in similar recovery (45.6 to 51.6%). However, at 1 colony level, again peak α produced more irreparable damage as evidenced by only 49.6% recovery compared to 64.0 to 65.8% after ^{60}Co γ and plateau α exposure. The oxygen effect varied according to the end point chosen, even for the same type of radiation. Nonetheless, a comparison of corresponding end points showed that peak α had a lower OER (2.02 to 2.22) than ^{60}Co γ (2.30 to 2.57) except for intestinal colony survival, and that although plateau α appeared to have slightly less oxygen effect than ^{60}Co γ, the difference was of doubtful statistical importance. Good correlation was noted between gut death and crypt cell survival and between marrow death and spleen CFU survival. (auth)

57998 (NIRS-Pu-8) FINAL REPORT OF RESEARCH PROJECT ON PLUTONIUM HAZARDS, APRIL 1966–MARCH 1970. Suzuki, Masashi; Tanaka, Eiichi; Matsuoka, Osamu (eds.) (National Inst. of Radiological Sciences, Chiba (Japan)). Apr 1971. 94p. Dep. NTIS (U. S. Sales Only).

ACETIC ACID, [(CARBOXYMETHYLIMINO) BIS (ETHYLENENITRILO)] TETRA-,—effects on excretion of plutonium-239 by rats
AEROSOL GENERATORS—development of plutonium
AIR SAMPLERS—design for monitoring plutonium-239 in laboratories
ALPHA PARTICLES—emission from mixed plutonium isotopes, proportional counter of measurement
AMERICIUM-241—decay scheme
ATMOSPHERE EXPOSURE CHAMBERS—development for plutonium aerosol inhalation studies on rats
AUTORADIOGRAPHY—method for whole-body measurement of plutonium-239 distribution in mice and
—method for high-speed measurement of alpha activity from polonium-210 or plutonium-239 on air filters
BIOLOGICAL MATERIALS—analysis for plutonium, radiochemical method
5 β-CHOLANIC ACID, 3, 7, 12-TRIOXO-,—effects on excretion of plutonium-239 by rats
DISEASES, TRAUMATIC—wounds, monitoring for plutonium, design of collimated alpha detector for
FILTERS—radio activity of air, high speed autoradiographic method for measurement of polonium-210 or plutonium-239
GAMMA RADIATION—emission from mixed plutonium isotopes, scintillation spectrometer measurement of rate of
LUNGS—plutonium-239 distribution studies of human, development of laminated lucite plate phantom for
—plutonium-239 deposition in human, development of large proportional and scintillation detectors for measurement of
MAN—plutonium hazards in, review
MICE—plutonium-239 distribution in, whole-body autoradiographic method for measurement of
PHANTOMS—development of laminated lucite plate human lung, for study of inhaled plutonium-239 distribution
PILOCARPINE—effects on excretion of plutonium-239 by rats
PLUTONIUM—determination in biological samples, method for
PLUTONIUM ISOTOPES—hazards for man, review
PLUTONIUM-238—decay scheme
PLUTONIUM-239—decay scheme
—distribution in lung tissues following inhalation, development of phantom for studies of
—content of human lungs, development of large proportional and scintillation detectors for measurement of
—distribution in mice and rats, whole-body autoradiographic method for measurement of
—excretion by rats, [effects of dehydrocholic acid, DTPA, and pilocarpine on enhancement of]
—monitoring in air, design of combined detector and sampler for
—content of human puncture wounds, design of collimated alpha detector for measurement of
PLUTONIUM-240—decay scheme
PLUTONIUM-241—decay scheme
PLUTONIUM-242—decay scheme
RADIATION DETECTORS, PROPORTIONAL—development of large-area, for measurement of plutonium-239 lung burden in man
RADIATION DETECTORS, SCINTILLATION—development of large-area, for measurement of plutonium-239 content of human lungs
—design of collimated, for measurement of alpha activity from plutonium-239 in puncture wounds
RADIOACTIVE WASTE—processing alpha-emitting, combined flocculation and ion exchange method for
RATS—plutonium-239 excretion by, effects of dehydrocholic acid, DTPA, and pilocarpine on enhancement of
—plutonium-239 distribution in, whole-body autoradiographic method for measurement of
X RADIATION—emmission from mixed plutonium isotopes, scintillation spectrometer measurement of rate of

57999 (NP-18944) DOSIMETRY OF IONIZING RADIATION ON DROSOPHILA MELANOGASTER. EFFECT ON THE SPONTANEOUS RATE OF DISJUNCTION AND LOSS OF CHROMOSOME X. de los Angeles Galindo Becerra, Ma. (Universidad Nacional Autonoma de Mexico, Mexico City. Facultad de Ciencias). 1971. 59p. (In Spanish). Dep. NTIS (U. S. Sales Only).

Thesis.

The use of Drosophila melanogaster as a biological dosimeter was investigated by testing two of the effects found in Drosophila: loss of chromosome X and disjunction of the heterochromosomes. The results showed that there is a relation, which is adjustable to a linear function, between the dose and the frequency of the chromosome X loss. No relation was observed for disjunction. It was concluded that the chromosome X loss could be adapted for use as a biological dosimeter. (J.S.R.)

58000 (RD/B/R-1934) BIOLOGICAL ASPECTS OF SKIN IRRADIATION. PART III. NEW EPIDERMAL THICKNESS MEASUREMENTS AND THEIR IMPORTANCE. Whitton, J. T. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Apr 1971. 54p. Dep. NTIS (U. S. Sales Only).

A new method for measuring epidermal thickness that is applicable in radiation dosimetry is described. The procedure has several advantages over conventional techniques since elasticity is accounted for. Quick measurements were made on 214 samples taken from 188 persons by means of a biopsy punch. Epidermal thickness was correlated with sex, age, and body site. The complete detailed results are given and discussed together with simplified adaptions for use in radiation protection. (UK)

58001 (UCRL-73388) PLEA FOR CONSISTENT LUNG BURDEN CRITERIA FOR INSOLUBLE ALPHA EMITTING ISOTOPES. Myers, David S. (California Univ., Livermore. Lawrence Radiation Lab.). [1969]. 13p. (CONF-710919-1). Dep. NTIS.

From eleventh symposium on the biological implications of the transuranium elements; Richland, Wash. (27 Sep 1971).

The maximum permissible annual dose to human lungs as defined by existing radiation standards is 15 rem/year. In the case of lung doses resulting from α-emitting isotopes, the assumption is made that the α energy is deposited uniformly in the lung tissue and that the mass of the lungs is 1000 grams. The amount of α activity in the lungs which will produce a dose rate of 15 rem/year is on the order of 10 to 20 nCi depending upon the effective half-life of the α-emitting isotope. In 1966 a revised lung model was promulgated by the ICRP Task Group on Lung Dynamics that more clearly defines the deposition compartments in the respiratory system, and considers the effect of particle size on deposition, the chemical form of the inhaled material, and the specific clearance pathways from the various deposition compartments. It is of special interest in the case of insoluble isotopes that the revised lung model stipulates that 15% of the activity deposited in the pulmonary region is eliminated to the pulmonary lymph nodes and that 90% of this activity is retained in these lymph nodes permanently. Based on this revised lung model, the dose received by the pulmonary lymph nodes is considerably greater than the dose received by the pulmonary region of the lungs for either acute or chronic inhalation of insoluble ^{239}Pu. Calculations were made of the integrated radiation dose to the lungs and the amount of activity remaining in the lungs 50 years following acute and chronic inhalation of ^{239}Pu. The parameters for each of the exposure categories and the corresponding computations are included. (C.H.)

58002 RADIATION UNITS AND THE MEASUREMENTS OF IONIZING RADIATION. Spiers, F. W. (Leeds Univ., Eng.). Phys. Educ.; 6: No. 5, 257-62(Sep 1971).

It is shown that a system of dosimetry, based on the concept of energy absorbed in the irradiated tissues, has evolved from earlier and more limited procedures. The absorbed dose unit, the rad, is satisfactory for the practical purposes of radiotherapy and radiation protection and is now in universal use. For a complete understanding of radiobiological effects, however, energy absorption must be considered at subcellular and molecular levels. Experimental and theoretical studies of the kind briefly described are now leading to greater precision in the concept of radiation dose and to deeper knowledge of radiation action. (UK)

58003 DOSE ESTIMATION IN TANGENTIAL RADIATION THERAPY. Takeshita, Kenji; Sunayashiki, Tadashi (Hiroshima Univ.). Nippon Igaku Hoshasen Gakkai Zasshi; 30: No. 9, 801-4 (Dec 1970). (In Japanese).

In tangential radiation therapy of the breast, dose distributions were obtained for one projection by calculating depth doses. The attenuation of ^{60}Co gamma rays in tissue was calculated using the linear absorption coefficient 0.055 cm^{-1} for the geometrical field. Contribution of secondary electrons absorbed at a point was limited to an area in a circle of which the radius was 0.5 cm on sagittal section. A rotation teletherapy unit was used with its fully opened field half shielded by lead. A film sandwiched between semi-cylindrical acrylite plates was tangentially exposed at the isocenter. Distributions obtained by these two methods were compared. The calculation technique is simple and reliable in estimating doses at any point in the breast during tangential and eccentric pendulum therapy. (auth)

58004 WHOLE-BODY ABSORBED DOSE FROM 44 keV AND 105 keV X RAYS AND ^{60}Co GAMMA RAYS. Kumamoto, Yoshikazu; Kato, Yoshio; Maruyama, Takashi; Shiragai, Akihiro; Yoshida, Yoshikazu (National Inst. of Radiological Sciences, Chiba, Japan). Nippon Igaku Hoshasen Gakkai Zasshi; 30: No. 2, 117-23(May 1970).

The absorbed dose in the head, arms, abdomen, legs, and whole body was obtained for a homogeneous phantom from 44 keV and 105 keV x rays and ^{60}Co γ rays by measuring the exposure distributions in water phantoms with an ionization chamber. The position of the phantom was in front of, to the side of, and at an angle of 45 degrees to the beam. The amount of absorbed dose in the whole body was 0.4 to 1.0 rad for 1 R of free air exposure. (auth)

58005 QUALITY FACTOR OF RADIATION. Zielczynski, M. (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 15: No. 11-12, 823-30(1970). (In Russian).

There are two definitions of the quality factor (QF): the first, in which QF is the expected relative biological efficiency of radiation for the general risk of body irradiation at low doses, and second, in which QF is a definite function of linear energy transfer (LET, L) of the particles ionizing the tissue. One can calculate, measure, and compare the quality factors of radiations according to the second definition with an accuracy limited by the diversity of meaning in formulation of the QF(L) function. It is suggested to take the QF−LET response of one of the known QF-detectors as a standard function. (auth)

58006 RADIATION SAFETY OF THE CREW OF SOYUZ-9. Vorob'ev, E. I.; Getselev, I. V.; Grigor'ev, Yu. G.; (and others). Kosm. Biol. Med.; 5: No. 4, 29-33(Jul-Aug 1971). (In Russian).

A careful analysis was made of the trajectory of the spaceship Soyuz-9 in order to evaluate the radiation hazards to be encountered. It was predicted that the combined galactic cosmic radiation and the radiation belts of the earth would not exceed an integral dose of 0.25 rad although part of the trajectory might be subject to 100 MeV protons, as a result of solar flares. Measurements of cosmic radiation were made in an artificial satellite, and from these and other data it was concluded that the integral cosmic radiation dose in the spaceship up to the completion of the flight would amount to 195 mrad (11 mrad per 24 hr), which did not represent a hazard to the cosmonauts. (K.S.W.)

58007 INDIVIDUAL RADIATION PLANNING AS PREREQUISITE FOR APPLICATION OF COMPLICATED TECHNIQUES IN MEGAVOLT THERAPY. Heilmann, H.-P. (Univ., Tuebingen, Ger.). Roentgenpraxis; 24: No. 7, 159-67(Jul 1971). (In German).

Since megavolt therapy permits high local radiation doses, exact individual planning becomes mandatory for optimal dose distribution in the tumor area. Descriptions are given for localization of the target area, radiometry methods, dose calculations, and control of equipment adjustment. The completed radiation plan, mostly obtained by computer, yields not only isodose curves but also important factors for pendulum irradiation, such as radius, depth of axis, width of aperture, angle for pendulum sectors, and exposure times. Several examples are given. (H.B.G.)

58008 COMPUTER PROGRAMS FOR IRRADIATION PLANNING IN HIGH-ENERGY THERAPY. Dobry, H.; Benedetti, G. R. (Siemens AG, Erlangen, Ger.). Electromedica; No. 3, 219-26(1970).

Data processing is becoming increasingly important in many branches of medicine. In radiotherapy the calculation of dose distribution is its most important task in the future. A general picture of the present state of development of dose computation by means of computer data processing and a detailed description of a program developed for betatron high energy and ^{60}Co γ units are presented. (auth)

58009 COMPUTER PROGRAM FOR DETERMINATION OF ISODOSE CURVES FOR ELECTRON ENERGIES FROM 5 TO 42 MeV. Benedetti, G. R.; Dobry, H.; Taumann, L. (Siemens AG, Erlangen, Ger.). Electromedica; No. 2, 57-60(1970).

The experimental determination of stationary field data and the resulting consequences for measurements of the radiation dose distribution from high-energy electrons used for therapy are discussed. A computer program is described that allows the calculation of stationary fields, multi-fields, and pendulum fields for electron energies of 5 to 42 MeV. (auth)

58010 DIRECT MEASUREMENT OF DOSE RATE IN THE BLADDER AND RECTUM USING THE GAMMAMETER. Glaser, F. H. (Martin-Luther Univ., Halle, Ger.). Electromedica; No. 1, 24-6(1969).

A radiation dose which exceeds the tolerance of the bladder and rectal mucous membrane during gynaecological contact curie therapy can lead to damage which will reduce the success of the treatment. Comparative evaluation of ^{60}Co applicator combinations in 600 female patients revealed that in over half of all cases the orientation resulted in over-exposure of between 50% and 90%. In order to incorporate a security factor a strict application time with regard to clinical requirement was established so that 5500 R to the bladder and rectum will not be exceeded. Even in the most unfavorable case, exposure to the mucous membrane will then not be greater than about 7000 R. The determination of the dose rate with a gamma meter provides a useful indication concerning the radiation exposure of bladder and rectum. The described method of direct measurement of the dose rate of the applicator in situ is regarded as the preferred method. (auth)

58011 EVALUATION OF TELEVISION CONTRIBUTION TO THE ANNUAL GENETICALLY SIGNIFICANT RADIATION DOSE OF THE POPULATION. Radiol. Health Data Rep.; 12: No. 7, 363-70(Jul 1971).

The X-radiation Ad Hoc Committee of the Electronic Industries Association used data from a U. S. Public Health Service survey of color television receivers in the Washington, D. C. area to estimate the annual genetically significant x radiation dose to the U. S. population from television usage. Using these data and various assumptions, the annual genetically significant dose was estimated by the committee to be 0.5 mrem. (auth)

58012 DIRECT METHOD OF MEASURING TOTAL RADIATION DOSE TO THE BRAIN USING THE FRICKE DOSIMETER. Werner, A.; Modan, B. (Tel Hashomer Government Hospital, Israel). pp 435-44 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Doses of radiation to the brain of children receiving x-ray therapy for tinea capitis were determined by the use of chemical dosimetry. The average dose absorbed by the brain of a 7-yr-old child was 99 ± 4 rads. This average dose measured with chemical dosimetry was compatible with the lower doses obtained with the ionization chamber method. An experimental model was devised to determine the effective photon energy of the radiation. On the basis of these results it is suggested that chemical dosimetry could have wider applicability in the measurement of doses absorbed by functionally homogeneous organs. (auth)

58013 USE OF CHROMOSOME ABERRATION FREQUENCIES FOR BIOLOGICAL DOSIMETRY IN MAN. Evans, H. J. (Western General Hospital, Edinburgh). pp 593-609 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The vast amount of work on chromosome aberrations induced by radiation exposure under defined biological and physical conditions, has shown that there exist strict relationships between aberration frequencies, radiation quality, and absorbed dose in a variety of cell systems. These relationships are such that in many irradiated plant and animal systems the frequency of induced chromosome aberrations was used to give reliable estimates of the radiation dose to which the system was exposed. A similar extrapolation from induced aberration frequency to absorbed dose can be made with human peripheral blood lymphocytes, if such cells are exposed and cultured in vitro under well defined

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conditions. Moreover, since aberrations induced in lymphocytes following an in vivo exposure can be detected in the cells when subsequently cultured in vitro, the peripheral blood leucocyte system was utilized for biological dosimetry in cases where individuals were accidentally exposed to radiations. In the case of uniform whole-body exposure of an individual, and under defined conditions of in vitro culture, the system may be expected to fulfil most of the requirements for a sensitive and accurate biological measure of absorbed dose. In this context, biological variations between individuals may be of importance and the influence of such factors as age and genotype on the radiation response is considered. In cases of partial-body exposure, there are a variety of biological factors that may have a considerable influence on the yields of aberrations measured in cells removed from the body shortly after exposure. Factors that are important include: the proportions of lymphocytes located in or passing through the radiation field at the time of exposure; the distribution and mobility of lymphocytes between peripheral blood and the lymphoid systems; differences in the radiation response of lymphocytes of differing types; and differences in the capacities of irradiated and non-irradiated lymphocytes to undergo mitosis in culture. Recent evidence bearing on these problems is discussed. (auth)

58014 USE OF RADIATION-INDUCED CHROMOSOME ABERRATIONS IN HUMAN LYMPHOCYTES FOR DOSIMETRY. Dolphin, G. W.; Purrott, R. J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). pp 611-22 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

During the past decade, techniques were developed for the analysis of radiation-induced chromosome aberrations in human lymphocytes. In the last few years there was an increasing awareness of the value of these techniques in dosimetry, where they were used to estimate doses in suspected or known cases of accidental over-exposure. Experience gained from these cases has shown that several factors have an important effect on the dose estimate. These factors are discussed in this paper. Published data relating dicentric aberration yield to in vitro irradiation dose show considerable variation from laboratory to laboratory. These data are reviewed and compared with similar values obtained at Harwell. Factors that affect the aberration yield include dose rate, type of radiation, culture time, and the ability of the cells to transform following irradiation. In order to obtain consistent calibration curves, standard conditions are suggested for irradiation of blood samples that closely resemble those for accidental in vivo irradiation. After in vivo irradiation, the measured dicentric yield is influenced by additional factors, particularly lymphocyte kinetics, and a short review of this subject is included. Some practical aspects are discussed including the dispatch and preparation of the blood sample taken after a radiation accident and the accuracy and sensitivity of this method of dosimetry. Future developments in chromosome dosimetry are considered and the need for automated recognition of aberrations is stressed. (auth)

58015 RELEVANCE OF CHROMOSOME ABERRATION YIELDS FOR BIOLOGICAL DOSIMETRY AFTER LOW-LEVEL OCCUPATIONAL IRRADIATION. Bauchinger, M.; Schmid, E.; Hug, O. (Institut fuer Biologie, Neuherberg, Ger. Univ., Munich). pp 623-32 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

The usefulness of chromosome analysis for biological dosimetry was tested in two groups of persons occupationally exposed to radiation: in nurses employed in gynaecological radiology, exposed especially when handling radium inserts; and in nuclear industry workers, all exposed to external gamma irradiation and some also to internal radiation after incorporation of various radionuclides. The total dose registered with personal dosimeters ranged in Group I from 0.1 to 91.7 rem accumulated over working periods of 0.1 to 13 yrs, and in Group II from 1.0 to 18.2 rem accumulated over 1 to 9 yrs. Compared with unexposed controls, both groups exhibit a significant increase of cells with chromosome aberrations as well as larger numbers of breaks per cell. Dicentrics and rings could be observed in some cells, providing good evidence for previous radiation exposure, since these types of aberrations are extremely rare events in unexposed individuals. No correlation between the aberration yields and the film badge values could be demonstrated in Group II. Also, in Group I the fluctuations from individual to individual were high. Nevertheless, a positive correlation to the dose was obtained. Even a sub-group of the nurses that had only been exposed to 20 rem showed significantly more aberrations than control persons. From the results obtained, type and frequency of chromosome aberrations may be considered an indicator of radiation exposure even at low doses. The reasons for lack of correspondence of chromosome aberration yields and the results of personal monitoring procedures are discussed in detail. (auth)

58016 USE OF CHROMOSOME ANALYSIS FOR BIOLOGICAL DOSIMETRY IN CONNECTION WITH AN ACCIDENT INVOLVING ^{226}Ra. Todorov, S.; Keslev, D.; Statelov, V.; Vasilev, G.; Ivanov, B. (Inst. of Engineering Physics, Moscow). pp 647-56 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

An incident with radium-226 directly involving two children aged twelve and thirteen is described. The physical and medical data obtained in this case are presented. A careful analysis of the numerical and structural chromosome damage suffered by the children was carried out by means of lymphocyte cultures. The dose received by the children was calculated on the basis of chromosome analysis. The observed chromosome injuries are compared with data from calibrated curves in the literature and with data obtained by the authors themselves through in vitro irradiation of lymphocyte cultures from human peripheral blood. (auth)

58017 APPLICATION OF THE PLASMA-QUENCHING EFFECT FOR EMERGENCY AND ACCIDENT RADIATION MONITORING. Mahmoud, K. A. (Atomic Energy Establishment, Cairo); Kotb, M. A. M. pp 657-63 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Due to the difficulty of devising a physical monitoring system that simulates in all respects biological organisms, it would be highly desirable to use biological monitoring methods. Changes in blood elements and, particularly, in plasma were selected as an appropriate biological indicator for personnel monitoring. Groups of rats were given whole-body doses between 25 and 250 rads from a ^{60}Co teletherapy unit. Blood samples were taken immediately after irradiation, and after periods of one-half day to sixteen days after exposure. The changes in the quenching effect of plasma as a result of these whole-body exposures were measured by means of liquid scintillation counting of tritiated water mixed with this plasma. The results indicate reproducible quenching effects that depend on the radiation dose for plasma samples taken just after irradiation. For plasma samples taken between one-half day and sixteen days after irradiation, the results indicate a recovery effect. The application of the method in emergency and accident monitoring is suggested. (auth)

58018 BIOLOGICAL DOSIMETRY METHODS EMPLOYED AT THE BORIS KIDRIC INSTITUTE OF NUCLEAR SCIENCES. Aleksic, B.; Veljkovic, D.; Djordjevic, O.; Djukic, Z. (Boris Kidric Inst. of Nuclear Science, Belgrade). pp 687-95 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

In addition to the more usual methods, the following methods are used at the Boris Kidrič Institute of Nuclear Sciences in the medical supervision of occupationally exposed staff: analysis of binucleated lymphocytes and chromosome aberrations; physical examination (for example, determination of the pain sensitivity threshold, adaptation to pain, discrimination of sensitivity); and capillaroscopy. These methods are described briefly and their practical application discussed. (auth)

58019 NEUTRON DOSE DETERMINATION WITH ACTIVATION AND BIOLOGICAL DETECTORS IN THE BORIS KIDRIC INSTITUTE. Trajkovic, M.; Miric, Ivanka; Ubovic, Z. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 697-703 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

A description of the dosimetric systems used in the Boris Kidrič Institute for the determination of neutron doses under accident conditions is given. The accident dosimeters consist of the following activation detectors: gold, copper, indium, sulphur, and magnesium. In addition, the sulphur in hair, and the blood sodium are used for evaluating the neutron dose values and for the determination of the distribution of the neutron doses during irradiation. For the evaluation of the neutron spectra the spectra index method was used. The dose values were determined for different spectra at the RA reactor at Vinča. The activation of the sulphur in hair, and the blood sodium, are correlated with the values obtained. The application of these physical and biological dosimeters and the expected precisions are discussed. (auth)

58020 COMPUTER PROGRAMS FOR IRRADIATION PLANNING IN HIGH-ENERGY THERAPY. Dobry, H.; Benedetti, G. R. (Siemens AG, Erlangen, Ger.). Electromedica; No. 5, 291-4 (1970).

Computer programs are presented for use in calculations of doses of high-energy γ and x radiation for therapy of neoplasms in inhomogeneous tissues. The programs allow calculations of the dose distribution as a function of wedge filter angle, filter material, and source-filter distance. (C.H.)

58021 COMPUTER PROGRAMS FOR IRRADIATION PLANNING IN HIGH-ENERGY THERAPY. Dobry, H.; Benedetti, G. R. (Siemens AG, Erlangen, Ger.). Electromedica; No. 4, 264-70 (1970).

Computer programs are presented for use in calculations of the therapeutic dose of high-energy γ and x radiations. The programs are written in FORTRAN IV, developed on the Siemens system 4004 and translated to the Siemens system 305, but they can be translated to other types of computer. (C.H.)

58022 X-RAY DOSE TO THE PATIENT IN MAXILLODENTAL TOMOGRAPHY. Sonnabend, E.; Polensky, F. (Georg-August Univ., Goettingen, Ger.). Electromedica; No. 3, 92-3(1971).

During the course of x ray tomography of the jaws and skull of 120 patients the dose was measured in the area of the head and gonads by means of ionization chambers and film dosimeters. Both skin dose and the gonadal dose were found to be greatly reduced as compared with normal 11-film fill-denture radiography. Moreover, the dose received by the patient during individual tomograms of the temporomandibular joint was ascertained and compared with the dose to the patient who was subjected to other methods of temporomandibular joint radiography (the functional radiograph). It was found that tomography lessens the dose to the patient and yields better diagnostic information. (auth)

58023 COMPARISON OF CALCULATED AND EXPERIMENTAL DOSE FIELDS OF A PROTON BEAM. Salamov, R. F.; Astrakhan, B. V.; Bal'ter, S. A.; Vainberg, M. Sh. (Inst. of Experimental and Chemical Oncology, Moscow). Med. Radiol.; 16: No. 9, 34-7(Sep 1971). (In Russian).

Data are presented on the experimental irradiation of human autopsy preparations of the neck and hip. The results of experiments were compared with data of calculations conducted with due consideration of the heterogeneity of the irradiated body and curvature of its surface. A good coincidence of calculated and experimental data was noted. (auth)

Radiation Protection

Refer also to abstract 58110.

58024 (CONF-711104-1) PROPER USE OF INFORMATION ON ORGAN AND BODY BURDENS OF RADIOACTIVE MATERIAL. Morgan, Karl Z. (Oak Ridge National Lab., Tenn.). [1970]. 22p. (SM-150/50). Dep. NTIS.

From Symposium on the assessment of radioactive organ and body burdens; Stockholm, Sweden (22 Nov 1971).

Applications of data on the uptake and retention of various radioisotopes by human body organs and tissues in establishing maximum permissible values for internal radiation doses are discussed. Criteria used in the development of radiation protection standards by the International Commission on Radiological Protection (ICRP) since 1934 are reviewed. It is postulated that changes in values of maximum permissible concentrations of a number of radioisotopes will be incorporated in the 1973 edition of the ICRP Internal Dose Handbook on the basis of new uptake and retention data. (C.H.)

58025 (ORNL-tr-2490) EXPOSURE TO RADIATION IN ORBITAL FLIGHTS. Swart, Hans. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Astron. Raumfahrt; No. 2, 58-61(1969). 5p. Dep. NTIS.

Data on the mean radiation doses absorbed by American and Soviet astronauts, as recorded by individual dosimeters during 18 space flights are presented as evidence that manned missions can be carried out with relatively slight exposure to radiation. The possible hazards of radiations for the personnel of space stations are considered, with emphasis on the hazards during solar flares. It is concluded that continual surveillance of solar activity and the provision of a shielded room to which the crew could retire during solar flares would provide adequate protection. Estimates of shielding requirements at various heights and orbital inclinations are included. (C.H.)

58026 ZASHCHITA ZHIVOTNYKH OT PORAZHENIYA YADERNYM ORUZHIEM. (Protection of Animals Against Injury by Nuclear Weapons). Karavaev, V. M.; Kolyakov, V. L.; Korzhevenko, G. N.; Il'in, V. G. Moscow; Izdatel'stvo Kolos (1970). 400p.

Types of injuries observed in domestic animals exposed to shock waves and radiations from nuclear weapons are discussed. Veterinary methods for the handling of irradiated animals are described. Shielding precautions necessary for the protection of domestic animals against injuries caused by nuclear weapons are described. Radiation syndromes, diagnostic methods, and methods for examining hides, organs, and tissues of irradiated animals for possible salvage are reviewed. Radiation dosimeters, ratemeters, and probes designed for use in the field are described. (280 references.) (K.S.W.)

Safety Procedures

Refer also to abstract 57972.

58027 OPERATIVE STATUTES OF RADIATION PROTECTION. Feher, L.; Gacs, F. Izotoptechnika; 14: No. 3, 35-49 (Mar 1971). (In Hungarian).

Hungarian regulations and statutes directed toward safety in work with radiation sources are reviewed and evaluated. (D.E.B.)

Legal Aspects

58028 (BRH/DMRE-71-4) STATE AND FEDERAL CONTROL OF HEALTH HAZARDS FROM RADIOACTIVE MATERIALS OTHER THAN MATERIALS REGULATED UNDER THE ATOMIC ENERGY ACT OF 1954 (AS OF OCTOBER 1, 1969). Pettigrew, George L.; Robinson, Earl W.; Schmidt, Gail D. (Bureau of Radiological Health, Rockville, Md. Div. of Medical Radiation Exposure). Jun 1971. 101p. GPO $1.00.

A study was made of State and Federal regulatory control of radium and accelerator-produced materials in the USA. A review of health hazards, a determination of the extent and magnitude of use, and an evaluation of the gaps and inconsistencies in present control of such materials are presented. The study revealed that radium is still used extensively in industry, medical applications, and consumer products. Despite this widespread use, which dates back many years, radium use is not regulated uniformly by all State and Federal agencies, nor is the control compatible with that exercised over AEC-regulated materials. Furthermore, there is no Federal authority to establish uniform and compatible use standards nor to require that sources and devices containing radium or accelerator-produced materials be manufactured or imported in accordance with minimum product safety standards. (auth)

Medicine

Refer also to abstract 57783.

58029 FIRST NATIONAL CONFERENCE ON CANCER OF THE COLON AND RECTUM, SAN DIEGO, CALIF., JANUARY 7-9, 1971. Cancer; 28: No. 1, 1-262(Jul 1971). (CONF-710115).

A separate abstract was prepared on one paper. Some 50 additional papers discuss various aspects of the diagnosis and pathology of cancer of the colon and rectum. (C.H.)

For an abstract of an individual paper see: 58111.

58030 USEFULNESS AND DAMAGES OF IONIZING RADIATIONS. Veraguth, P. (Hopital Cantonal, Lausanne, Switzerland). Rev. Med. Suisse Romande; 89: No. 3, 225-35(Mar 1969). (In French).

Usefulness and hazards of ionizing radiations are discussed with emphasis on the medical field. Also discussed are the merits of x radiation for testing of metallic welds, sterilization of materials, and spectrographic analysis of crystals. Radiation hazards are considered for both medical and technical application. In med-

XUM

icine, the beneficial effects have to be weighed against the possible side effects. (H.B.G.)

Protective Substances

Refer also to abstracts 57974, 58087, 58094, 58155, and 58157.

58031 CHANGE IN THE LEVEL OF REDOX POTENTIAL IN MUSCLES OF DIFFERENT ANIMAL SPECIES AS A FUNCTION OF THE DOSE OF CYSTAMINE INTRODUCED. Vladimirov, V. G.; Yusipov, V. S.; Poddubskii, G. A. (Military-Medical Academy, Leningrad). Radiobiologiya; 11: No. 1, 102-5(1971). (In Russian).

The influence of various doses of cystamine after intravenous injection on the level of the redox potential in the muscle was studied in experiments on mice, rats, and dogs. It was shown for all the species of animals that the decrease in the redox potential is directly proportional to the dose of the protector; however, in different species, within a definite dose range, the decrease in the redox potential is inversely dependent upon the level of metabolism in the animal organism. On the basis of the experimental data obtained, a formula was proposed that reflects the ratio of the doses of cystamine in mice and dogs, equally effective with respect to their ability to change the redox potential in the muscles of these animals. (tr-auth)

58032 RADIOPROTECTIVE ACTION OF VERSENE ON GAMMA IRRADIATED BACTERIOPHAGES. Masironi, Roberto; Kriviskii, Alexander S. (Inst. of Molecular Biology, Moscow). Riv. Biol.; 61: No. 1, 35-41(Jan-Mar 1968). (In Italian).

Bacteriophages used in the investigation were T_2, ϕX174, N 1, and Sd. Suspensions of phage were diluted in phosphate buffer at pH 7.2 and gamma-irradiated as follows: in the dry state, in 4% nutrient broth, in phosphate buffer, in phosphate buffer containing versene, in broth containing versene, and in phosphate buffer with versene added after irradiation. Results indicated that versene was a good radioprotective agent. Contrary to results of ultraviolet radiation experiments, versene was effective when employed in complex form and when added after irradiation. Phage ϕX174 was protected against gamma radiation, but not against ultraviolet radiation. (H.L.W.)

58033 EFFECT OF TISSUE PREPARATIONS ON IRRADIATED LABORATORY ANIMALS. Shcheglov, S. M. Cesk. Radiol.; 24: No. 5, 215-16(Sep 1970). (In Russian).

The biological effect was studied of SEP (a bone marrow preparation) and antianemin on the survival of mice X-irradiated with 350, 400, and 500 R, and of complex preparation GS-7 (a preparation stimulating haemopoiesis) and of SEP on the survival of rabbits irradiated with 1100 R. Results are also presented of the differential blood count. All preparations were found to favourably affect the survival of irradiated animals; GS-7 was the most effective preparation, the effectivity of SEP was lower, and that of antianemin the lowest of the three. Due to its biological properties, the GS-7 complex preparation has a stimulating effect on blood formation; this makes it valuable for radiation pathology. (NSA of Czech)

58034 IN VIVO STUDIES OF RADIATION POTENTIATION BY IODOACETAMIDE AND OBSERVATIONS ON TUMOR TRANSPLANTATION IMMUNITY. Richards, William Robert. Berkeley, Calif.; Univ. of California (1970). 124p. University Microfilms Order No. 71-20,898.

Thesis.

Iodoacetamide has been shown by others to be a radiation sensitizer for bacteria and for certain mammalian cells tested in vitro. This work describes an examination of the effectiveness of iodoacetamide used in vivo. Survival of ascites tumor cells maintained in the peritoneal cavity of mice was used as an indicator of sensitization. Survival was assessed using TD_{50} and total tumor cell population determination methods. A comparison of results obtained by these methods is made. The effects of oxygen tension and radiation dose rate upon results was examined. Iodoacetamide was found to be effective as a radiation sensitizer under all conditions although to a lesser degree than that reported by others for in vitro experiments with bacteria. Radioactive tracer studies indicate that iodoacetamide has rapid and total access to most if not all tissues of the body. This fact coupled with the observation of a sensitization in an in vivo system where the anoxia so prevalent in well developed tumors was present, suggests the possibility of clinical usefulness of iodoacetamide in cancer radiation therapy. Certain observations are reported on the effect of various cell and host treatment procedures upon cell population growth kinetics seen subsequent to inoculation of hosts with the cells. A hypothesis is presented which can account for the observations made by the author and also for those made by some others who report that large inocula, i.e., greater than 10 cells, are required to give rise to a lethal tumor in isologous hosts of the strain of tumor origin. The hypothesis may also account for what is known in the literature as the "Hybrid Effect." (Diss. Abstr. Int., B)

58035 INFLUENCE OF ADRENAL CORTEX TOTAL EXTRACTS ON RADIATION SICKNESS. Hartmann, U.; Soost, H.-J. (Univ., Munich). Ther. Gegenw.; 110: 539-45(Apr 1971). (In German).

In a double-blind clinical study, 61 patients with cervical cancer received either 6 mg of total adrenal cortex extract or a placebo following radiotherapy. The initial reaction to radiation was then compared. Statistical evaluation of the data revealed no significant difference between adrenal cortex and placebo groups; however, clinical observations indicated enough improvement of the treated group to justify continuation of the study. (H.B.G.)

58036 EXPERIMENTAL STUDY OF AGENTS PROTECTING THE SKIN AGAINST ACUTE RADIATION ULCERATION. Chaudhuri, S. K.; Lal, K.; Chakravarti, R. N. (Post-Graduate Inst. of Medical Education and Research, Chandigarh, India). Indian J. Med. Res.; 58: 1413-20(10 Oct 1970).

An experimental study on rabbits was undertaken to investigate the effect of x-irradiation on the skin and to evaluate the role of methionine, desoxycorticosterone acetate, vitamin A and local wound as protective agents against acute radiation ulceration. X-irradiation was given and the animals were observed for a maximum period of 65 days. The parameters of study for therapeutic evaluation were general condition, body weight, naked eye study of the post-irradiation reactions, measurement of post-irradiation wound and histological examination of skin from the irradiated and unirradiated areas. These studies were done at different periods. The control as well as animals treated with methionine and DOCA invariably had post-irradiation reactions, but only three and two animals treated with vitamin A and prior wound respectively showed some evidence of post-irradiation reaction. Healing of the post-irradiation wounds by scab formation was a common feature in all the animals showing post-irradiation reactions. The scab fell off leaving a glistening pearly white soft apparently normal skin. A statistical assessment showed maximum amount of tissue necrosis in control animals, while it was minimum in vitamin A treated animals. The difference as regards amount of tissue necrosis, was highly significant ($p < 0.01$). Production of prior wound at the site of irradiation retarded tissue necrosis to a marked degree. (auth)

Radiation Sickness and Injuries

58037 TUMORS OF THE SKIN. XII. TOPICAL 5-FLUOROURACIL FOR EPIDERMAL NEOPLASMS. Klein, Edmund; Stoll, Howard L. Jr.; Milgrom, Halina; Helm, Frederick; Walker, Mary J. (Roswell Park Memorial Inst., Buffalo). J. Surg. Oncol.; 3: No. 3, 331-49(1971). (CONF-690457-2).

From Symposium on recent advances in the management of skin neoplasms; New York, N. Y. (11 Apr 1969).

The optimal dose of topical 5-fluorouracil in late radiation dermatitis in man varies with the extent of the dermatitis and the type of lesions. The dose was determined in a group of 17 patients by progressive increase in the concentration from 0.05% 5-FU until a concentration was reached which gave an adequate response without untoward intensity of local side-reactions. Late radiation dermatitis in areas other than the face, such as the back, the neck, and the upper arms, usually responded satisfactorily to a 5% 5-FU concentration. Individual lesions persisting after topical treatment to larger areas were treated with concentrations of up to 20% 5-FU. The adjacent skin frequency showed an inflammatory reaction to the higher concentrations of 5-FU which subsided within five to seven days. Healing of the sites of lesions may require two to four weeks after terminating chemotherapy. (auth)

58038 RADIONECROSIS OF THE SKIN. TASKS FOR A MEDICAL GROUP. Drepper, H.; Ehrings, F.; Vojtech, D. (Westfaelische Vereins fuer Krebs- und Lupusbekaempfung, Muenster, Ger.). Med. Welt; 5: 155-62(30 Jan 1971). (In German).

When ulcers occur in atrophic skin caused by x radiation, possibility of malignancy must be excluded as a first step. Malignancies can be either radioinduced or metastatic. Various types of conservative treatment of radiation ulcers are discussed with respect to solutions, ointments, and antibiotics. If tissue necrosis is too deep, exposed to too much tension, and caused by too high radiation doses, plastic surgery becomes necessary. Coverage by skin flaps, full thickness skin grafts, and split skin grafts are discussed. (H.B.G.)

58039 REGIONAL APPROACH TO THE MANAGEMENT OF RADIATION ACCIDENTS. Linnemann, Roger E.; Thiessen, Joop W. (Radiation Management Corp., Philadelphia). Amer. J. Public Health; 61: No. 6, 1229-35(Jun 1971).

A regional program for the management of radiation accidents represents a feasible and practical answer to a major challenge associated with the nuclear age. By coordinating the medical capabilities of a regional treatment center with those of supporting hospitals and potential accident sites, this plan appears to be the most effective means of discharging the nuclear community's obligation to the public, and the medical profession's responsibility to the nuclear community. (auth)

Radiodiagnosis

Refer also to abstracts 57754, 57760, 57763, 57770, 57774, 57784, 57785, 57823, 58022, 58105, and 58136.

58040 (UCLA-12-834) COMPARISON OF RADIOAEROSOL VERSUS RADIOXENON INHALATION PROCEDURES IN OBSTRUCTIVE LUNG DISEASE AND PULMONARY EMBOLISM. Taplin, George V.; Poe, Norman D.; Isawa, Toyoharu; Dore, Earl K. (California Univ., Los Angeles. School of Medicine). [1971]. Contract AT(04-1)-Gen-12. 33p. Dep. NTIS.

The advantages of scintillation camera lung imaging following the injection of ^{99m}Tc-labeled albumin macroaggregates, the inhalation of ^{113m}In-labeled albumin aerosols, and the inhalation of ^{133}Xe for the evaluation of blood perfusion and ventilation and the localization of even relatively small lung neoplasms are discussed. It is pointed out that perfusion and inhalation lung imaging should be performed in rapid sequence whenever underlying obstructive airway disease is suspected. The combined data from both perfusion and inhalation lung imaging is useful for the diagnosis and localization of neoplasms, disturbances in air flow dynamics and regional ventilation, emphysema, pulmonary embolisms, and disturbances in blood circulation. (C.H.)

58041 (UCLA-12-837) COMPARATIVE MYOCARDIAL UPTAKE AND CLEARANCE CHARACTERISTICS OF POTASSIUM AND CESIUM. Poe, Norman D. (California Univ., Los Angeles). [1971]. Contract AT(04-1)-Gen-12. 13p. Dep. NTIS.

Potassium-43 and its analog, cesium-129, have recently been suggested as suitable radiopharmaceuticals for myocardial scanning. Studies with potassium-42 and cesium-131 were undertaken in dogs to determine the myocardial turnover characteristics of these two ions. After simultaneous intravenous injection, potassium clears rapidly from the blood, reaches a plateau in the myocardium within 5 to 20 minutes, and then clears with a T 1/2 of 6.5 hours. Initial cesium clearance is slower. A peak is reached gradually in the myocardium within 1 to 3 hours and the clearance T 1/2 is 27.3 hours. Following intracoronary injection, potassium is extracted with 71% efficiency on a single circulation, but cesium is extracted with only 22% efficiency. It is concluded that cesium should be utilized with caution as a substitute for potassium in quantitative myocardial blood flow and function measurements, but that comparable results can be obtained with either radionuclide in localizing ischemic myocardium. (auth)

58042 STUDIES ON LIVER FUNCTION TEST WITH ^{131}I BSP MONOIODIDE AND SCINTICAMERA. Torizuka, Kanji; Hamamoto, Ken; Morita, Rikushi; (and others) (Kyoto Univ.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 113: No. 1, 41-9(Sep 1971).

From the studies on the usefulness of ^{131}I-bromosulphalein (BSP) for the liver function test with scinticamera, 1600 channel pulse height analyzer, and digitizing magnetic tape recorder, the following procedure is recommended as routine for obtaining the liver function and liver visualization: the blood is drawn at 10 minutes after the intravenous administration of 150 μc ^{131}I BSP monoiodide; the percent retention of ^{131}I BSP in serum at 10 minutes is estimated from the ^{131}I BSP concentration in serum at 10 minutes, and the total serum volume obtained from the body weight and body height. The scintigraphy is performed at 30 to 60 minutes. (auth)

58043 EFFECTS OF pH ON ^{113m}In DISTRIBUTION, IN ORDER TO SIMPLIFY THE PREPARATION OF ^{113m}In FOR BLOOD POOL AND LIVER SCANNING. Watanabe, Katsushi (Kyushu Univ., Fukuoka); Kawano, Yoshiaki. Kaku Igaku; 7: No. 1, 8-15(May 1970). (In Japanese).

The effects of pH on ^{113m}In distribution in mice were studied to determine how precisely pH should be adjusted. Activity of ^{113m}In in blood was high at pH 3.5 ± 1.0 both with and without heating. Therefore, blood pool scanning can be done sufficiently with ^{113m}In solution in this range of pH value. The liver concentration reached approximately 78% at pH 10.5 without heating and over 70% in the range of pH 10.5 ± 0.5. With heating, the liver concentration of ^{113m}In was approximately 80% at pH 8.5 to 9.5 and over 70% in the range of pH 9.5 ± 1.0. Incubation led to higher liver concentrations. However, liver scanning can be done effectively with ^{113m}In adjusted to pH 10.5 ± 0.5 without heating. It was found that ^{113m}In use for blood pool scanning and liver scanning did not require strict adjustment of pH. In the preparation of ^{113m}In for this purpose, pH measurement and autoclaving can be omitted by using a sterile generator and sterilized reagents. (Japan)

58044 ANGIOGRAPHY, SCINTILLATION SCANNING, AND ULTRASOUND TOMOGRAPHY OF THE LIVER. Fuchs, W. A.; Voegeli, E.; Schwegler, N.; Huenig, R.; Roesler, H. (Univ., Bern). Schweiz. Med. Wochensch.; 32: No. 101, 1180-6(14 Aug 1971). (In German).

A comparative study of angiography, scintillation scanning, and ultrasound tomography in the diagnosis of space-occupying lesions of the liver was made in 20 patients. Ultrasound tomography and scintillation scanning are screening methods which provide a more precise indication for angiography. (auth)

58045 POSITIVE SCINTIPHOTOGRAPHY OF CANCER OF THE LIVER WITH ^{67}Ga CITRATE. Suzuki, Takashi; Honjo, Ichio; Hamamoto, Ken; Kousaka, Tadako; Torizuka, Kanji (Kyoto Univ.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 113: No. 1, 92-103(Sep 1971).

Twenty-five patients with histologically proven cancer of the liver were studied with liver scintiphotography using ^{67}Ga citrate. Of 25 cases, five (four hepatomas, one metastatic cancer) showed increased uptake of ^{67}Ga citrate in the tumor, eight (three hepatomas, one cholangioma, four metastatic cancers) showed equilibrated uptake, six (all metastatic cancers) showed decreased uptake, and the remaining six (two hepatomas, four metastatic cancers) showed undetermined uptake. Of the cases in which ^{67}Ga citrate in the tumor showed poor uptake, three had effective treatment of the lesions prior to the study. (auth)

58046 SCINTILLATION SCANNING OF LIVER CELL ADENOMA. Sackett, Joseph F.; Mosenthal, William T.; House, Reginald K.; Jeffery, Robert F. (Mary Hitchcock Memorial Hospital, Hanover, N. H.). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 113: No. 1, 56-60(Sep 1971).

Scintillation photoscannings with ^{99m}Tc sulfur colloid and ^{131}I rose bengal were performed in a 33 year old female before and after partial liver resection for benign adenoma. The benign nature of the functioning liver cell adenoma, seen in the photoscans, correlates well with the gross and microscopic pathologic changes. The adenoma takes up both radionuclides to almost the same degree as normal liver tissue. (auth)

58047 PROCESS OF MANUFACTURING RADIOACTIVE SUBSTANCES DERIVED FROM DIFLUORESCENYLMERCURY AND LABELLED WITH RADIOACTIVE IODINE ISOTOPES. Ratusky, Josef; Kronrad, Leo; Malek, Prokop; Kolc, Jiri; Vavrejn, Bohuslav (to Ceskoslovenska Akademie Ved). British Patent 1,240,786. 28 Jul 1971. Priority date 20 Dec 1968, Czechoslovakia.

A method is presented for the preparation of ^{125}I- or ^{131}I-labeled difluoresceinylmercury compounds, which are seen to be superior for clinical diagnosis of ischemically injured tissues or experimental work to their currently used ^{197}Hg- or ^{203}Hg-labeled sister compounds. Radioactive iodinated fluorescein derivatives may be prepared synthetically or by exchange reactions. These derivatives are reacted with compounds of bivalent mercury, as illustrated by the following equations: fluorescein + $HgX_2 \rightarrow$ XHg-fluoresceinyl + HX; and, XHg-fluoresceinyl + fluoresceinyl $\rightarrow$ fluoresceinyl-Hg-fluoresceinyl + HX. (J.G.B.)

58048 SCHILDER'S DISEASE. POSITIVE BRAIN SCAN. Valenstein, Edward (Harvard Medical School, Boston); Rosman, N. Paul; Carter, Anthony P. J. Amer. Med. Ass.; 217: No. 12, 1699-1700(20 Sep 1971).

A case history is presented for a 12-year old boy with a diagnosis of Schilder's disease in whom a ^{99m}Tc brain scan showed abnormal findings. (C.H.)

58049 HANDBOOK FOR TECHNOLOGISTS OF NUCLEAR MEDICINE. Hudak, Julia S. Springfield, Ill.; Charles C Thomas, Publisher (1971). 163p. $8.75.

Procedures using radioisotopes for in vivo and in vitro clinical diagnostic tests are outlined. The characteristics and operation of radiation detection instruments used routinely and methods for sample preparation are described. The purpose of each test, the dose of each radioisotope administered, the interpretation of results, and guidelines and contraindications for the administration of each radioisotope are included. Precautions to be taken to

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minimize the radiation exposure of both patients and personnel are described. (47 references.) (C.H.)

58050 A NEW AGENT FOR LIVER SCANNING: $^{131}I-T_3$. Tatsuno, Ikuro (National Hospital of Kanazawa, Japan). Kaku Igaku; 7: No. 2, 111-17(Jun 1970). (In Japanese).

Patients were injected with ^{131}I labeled triiodothyronine ($^{131}I-T_3$) and scintiscans were made of the liver. Excellent scintigrams were obtained and several advantages were noted when compared with $^{131}I-T_4$ (^{131}I-thyroxine) or ^{198}Au colloid. Maximum radioactivity, and sufficient to scan the liver, was reached about 5 min after intravenous injection of $^{131}I-T_3$, whereas 120 to 180 min were required with $^{131}I-T_4$, so that scanning could be started immediately after the injection of $^{131}I-T_3$. The space-occupying lesion in the liver, confirmed by autopsy, was more accurately and clearly delineated than when using colloidal ^{198}Au. The biological half-time of $^{131}I-T_3$ in the liver was 2 to 3 hrs compared to 30 to 90 hrs with $^{131}I-T_4$. The radiation dose to the liver from $^{131}I-T_3$, $^{131}I-T_4$, and ^{198}Au was determined by the Quimby formula. The radiation dose to 1,200 g of liver (which is the average weight for Japanese males) from 200 μCi of $^{131}I-T_3$ was approximately 0.25 rad. Thus the radiation dose can be reduced to $^1/_{25}$ that received from 120 μCi of colloidal ^{198}Au, the most widely used tracer dose in this department. (auth)

58051 USE OF RADIOACTIVE TRACERS IN THE STUDY OF BREAST CANCER. Tarolo, G. L. (Univ., Milan); Colombo, L.; Calvi, A. Radiol. Med.; 56: No. 11, 1036-48(Nov 1970). (In Italian).

Radioactive tracer uptake was determined in 42 patients with unilateral breast nodules awaiting biopsy or mastectomy. The tracers employed were ^{32}P, ^{197}Hg, and ^{75}Se. Comparison with the histological data showed: that ^{197}Hg bichloride gave the smallest number of false negatives; that slight uptake occurred in some benign nodules, with values approaching those considered typical of malignancy in rare instances; and that uptake was quantitatively determined by the growth rate of the neoplasm. It was concluded that this method is less useful as screening test than in the study of the metabolic and development features of known or suspected malignant tumors for the purpose of obtaining reliable information with respect to prognosis and planning of treatment. (auth)

58052 ^{111}In: A NEW RADIOISOTOPE FOR CYSTERNOSCINTILLOGRAPHY. Fuenzalida, S.; Bennett, L. R.; Larson, J. M. (Univ. of California, Los Angeles). Rev. Biol. Med. Nucl.; 3: No. 1, 25-9(Feb 1971). (In Spanish).

Most of the centers are employing ^{131}I-albumin and more recently ^{99m}Tc-albumin for cisternoscintigraphy. ^{111}In-albumin gives advantages over both. ^{111}In has a half life of 2.8 days which is useful when late controls are necessary. It has very good γ energies, 173 and 274 keV, similar to ^{99m}Tc, and a minimum contribution of internal conversion electrons. This produces an irradiation dose smaller than ^{131}I. A method for the preparation of the ^{111}In-albumin with a high specific activity is described. Serial cisternoscintigrams were obtained in 12 adult dogs following the injection of 1 mCi intracisternally using a magnascanner. Excellent cisternoscintigrams were obtained within 3 hours and 7 days. These studies suggest that ^{111}In-albumin can be the compound of choice for cisternoscintigraphy. (auth)

58053 STUDY OF THE RETICULOENDOTHELIAL SYSTEM IN HEMATOLOGICAL DISEASES. Dibos, P. E.; Spaulding, M. B.; Judisch, J. M.; Wagner, H. N. Jr.; McIntyre, P. A. (Johns Hopkins Medical Institutions, Baltimore). Rev. Biol. Med. Nucl.; 3: No. 1, 30-5(Feb 1971). (In Spanish).

A study was made in order to evaluate the usefulness of the visualization of the liver, the spleen, and the functional bone marrow in patients with hematological diseases. More than 180 scintigraphic studies were made; all of them with ^{99m}Tc-colloidal and Anger Camera. All the patients with polycythemia vera (eleven) showed a marked hyperplasia of the bone marrow reticuloendothelial system (RES). But in cases of polycythemia due to stress, the images were normal. The twelve patients with myelofibrosis showed a serious bone marrow hypoplasia. A significative distal expansion was observed in cases of chronic hemolitic anemia, pernicious anemia, and iron deficiency. Fourteen patients with Hodgkin's disease (degrees III and IV) and 20 patients with other lymphomas were studied. All these patients showed abnormalities in the RES scintigrams, and six of eight patients with myeloma showed a severe hypoplasia of the bone marrow RES. These studies show that the RES images, including liver, spleen, and bone marrow, can be useful in the differential diagnosis of polycythemias and myeloproliferative diseases and in the determination of lymphoma clinical state. (auth)

58054 ^{75}Se-SELENOMETHIONINE IN THE SCINTALLOGRAPHY OF THYROID AND HEPATIC LESIONS. Maisterrena, Jorge A.; Tovar Z., Enrique; Cervantes, Abelardo; Tello R., Carlos (Instituto Nacional de la Nutricion, Mexico City). Rev. Biol. Med. Nucl.; 3: No. 1, 18-24(Feb 1971). (In Spanish).

Thyroid nodules that do not concentrate iodine represent a medical problem. Hepatic lesions that show themselves as a defect of radioactive colloid concentration are in the same category. The scintigraphy of these lesions with ^{75}Se-selenomethionine gives information that helps to resolve this problem to a certain degree. Results are reported from a study that consisted in the administration of 250 microcuries of ^{75}Se-selenomethionine intravenously and obtaining a scintigram at 1, 24, 48, and 72 hours over the area of interest. The material consisted of ten patients with thyroid lesions and five patients with hepatic lesions. The thyroid nodules having a great cellularity concentrated more amino acid than the surrounding tissues. In the liver, the primary tumors concentrated the amino acid also perhaps because it is a tissue with protein synthesis capacity. The scintigram with ^{75}Se-selenomethionine suggested that the degree of cellularity and/or the capacity to synthesize proteins in the studied tumors is related to the amino acid concentration degree. In all the cases in which a histological study was made, there was a good correlation between protein synthesis and the scintigraphic findings. (auth)

58055 CLINICAL IMPORTANCE OF THE STUDY OF THE LYMPHATIC SYSTEM WITH RADIOISOTOPES. Harbst, Hans; zum Winkel, Karl (Freie Univ., Berlin). Rev. Biol. Med. Nucl.; 3: No. 1, 11-17(Feb 1971). (In Spanish).

The examination of the lymphatic system with radioisotopes is based on the absorption of a labeled colloidal substance. Lymph node metastases of solid tumors and displacements of the node chains or blockage of the lymphatic ducts are shown on the scintigram. In the inflammatory processes, the quantity of substance fixed by the lymphatic RES is reduced compared with the normal lymphatic nodes. Malignant lymphoma appears as a diminution in the uptake of the radioactive tracer in large lymphatic areas. The comparative study of scintigraphy with the direct radiography, using lipiodol, of the abdominal lymphatic chains made on 460 patients showed that in 70% of the cases with normal scintiscans or with evident pathological alterations the radioisotopic study was sufficient. In 30% of the cases, the scintiscan had to be supplemented with Lipiodol lymphography. The scintigram was useful in the representation of the abdominal, axilar, supraclavicular, and cervical lymphatic chains. The study of the retrosternal lymphatic system is of great importance, especially for patients with breast tumor, before and after radiotherapy. The uptake by some lymph tumors of citrates labeled with ^{67}Ga administrated intravenously has opened new possibilities for the early diagnosis of some malignant disorders of the lymphatic system. (auth)

58056 LEAKAGE PHENOMENON IN THYROID GLAND TUMORS. Roesler, H. (Univ., Bern). Electromedica; No. 5, 312-20(1970).

Serial scintigraphy of the thyroid gland allows the identification of regional differences in the accumulation and elimination of ^{131}I in the gland. The leakage phenomenon, which proves an accelerated elimination of radioactive iodine, is described in tumors of benign and malignant histology with effective and ineffective iodine metabolism. This phenomenon is seen in toxic adenoma with strongly increased PBI-131 and, in a case of struma maligna Langhans, was an additional indication of a functional dedifferentiation of the tumor and of a clinical cause of an accompanying hyperthyroidism. In the case of a solid thyroid gland carcinoma, the spontaneous leakage phenomenon was the result of an iodization insufficiency peculiar to the tumor. This faulty utilization of iodine was proved by a control series with perchlorate loading in which the serial scintigraphy provided the finding of an exogenous accelerated leakage phenomenon. Toxic adenomas with a positive leakage phenomenon should be treated by surgery. Also in the case of proven iodine insufficiency, the radical operation and the subsequent, high-dose and repeated treatment with radioactive iodine of the struma maligna are justified. (auth)

58057 RECTILINEAR SCANNING. Deland, F. H. (Univ. of Florida, Gaineville). Electromedica; No. 3, 80-2(1971).

Radionuclide imaging reveals lesions as either an area of increased or decreased radioactivity relative to the surrounding level of activity. In larger organs the tomographic effect of rectilinear instruments enhances the detection of deeper lesions. The dual probe scanners, which provide two images simultaneously, provide markedly decreased examination time and permit more thorough examination of the patient and improved diagnosis. (auth)

58058 MEASURING THE BLOOD FLOW THROUGH THE BRAIN WITH THE AID OF ^{133}Xe. Hacker, H. (Johann-Wolfgang-Goethe Univ., Frankfurt am Main). Electromedica: No. 2, 189-94(1970).

Recording of the loss of radioactivity in circumscribed regions of the brain after injection of ^{133}Xe in the internal carotid artery makes it possible to calculate the regional cerebral blood flow from the washout curve. The procedure adopted for such investigations is described that led to new ideas about cerebral vasomotoricity and made possible a more exact diagnosis of cerebral ischaemic conditions. (auth)

58059 EVALUATION OF PHOTO-SCINTIGRAMS BY MEANS OF TELEVISION REPRODUCTION AND SUBTRACTION. **Feine, U. (Univ., Tuebingen, Ger.). Electromedica: No. 2, 42-4(1969).**

A technique for the evaluation of photoscintigrams is described which employs contrast intensification of the television image and, specially for pancreas scintigraphy, the subtraction of two television images. This method is also suitable for the subsequent evaluation of poorly exposed photoscintigrams. The method of double labeling the liver in pancreas scintigraphy with ^{75}Se-methionine and ^{198}Au colloid was used. (auth)

58060 SCINTIGRAPHIC DIAGNOSIS BY MEANS OF SHORT-LIVED RADIONUCLIDES. **Wolf, F.; Kroenert, E. (Univ., Erlangen, Ger.). Electromedica: No. 2, 33-7(1969).**

The advantages of using short-lived metastable radioisotopes for scintigraphic diagnostic studies are discussed. The properties of ^{99m}Tc and ^{113m}In are described and their scope of practical application is demonstrated by scintigraphic studies of the brain, liver, stomach wall, and placenta. (C.H.)

58061 SOME PRACTICAL CONSIDERATIONS ON PANCREATIC SCANNING. **Iwig, J. (Johanniter-Krankenhaus Rheinhausen, Kreuzacker, Ger.). Electromedica: No. 4, 258-60(1970).**

A technique for scintigraphy of the pancreas following the intravenous injection of ^{75}Se-selenomethionine is described. A method for patient preparation and positioning is described that eliminates the need for simultaneous ^{198}Au liver subtraction scanning. The method produced good scintigrams of normal and pathological pancreas in a series of 160 studies. (C.H.)

58062 NEW EVALUATION AND GRAPHIC REPRESENTATION OF SCINTIGRAPHY: THE CURVE SCAN. **Seyss, Ruediger. Radiol. Clin. Biol.; 40: No. 4, 261-9(1971). (In German).**

A modification of radioisotope scanning with statistical analysis of data is described which permits a continuous quantitative representation of the activity distribution in the examined organ. The technique is explained and the advantages of this method are described. (auth)

58063 MEDICAL PROBLEMS IN EYE TUMOR IDENTIFICATION. **Larose, James H.; Jarrett, W. H.; Hagler, William S.; Palms, John M.; Wood, Robert E. (Emory Univ., Atlanta). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 46-9(Feb 1971).**

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).
NSA

The diagnostic accuracy of the ^{32}P uptake test for differentiating between benign and malignant melanomas of the eye is discussed. A method for administering the test, in which a meticulous surgical procedure is used to ensure adequate localization of the suspected lesion and direct placement of the radiation detector over the lesion, is described. (C.H.)

58064 EYE TUMOR IDENTIFICATION TESTS USING SEMICONDUCTOR DETECTORS. **Palms, John M.; Wood, Robert E.; Larose, James H.; Jarrett, W. H.; Hagler, William S. (Emory Univ., Atlanta). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 50-6(Feb 1971).**

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A comparison was made of the performance of the conventional Geiger–Mueller eye probe and several eye probes using semiconductor detectors for measurements of the low-energy β radiation emitted by tracer doses of ^{32}P used for the diagnosis of eye melanomas. Silicon lithium drifted [Si(Li)], silicon surface barrier, and silicon avalanche β detectors were tested. The results indicate that the Si(Li) posterior probe detector gave the most consistent, sensitive, and reliable results. (C.H.)

58065 PROCESSING DATA IN NUCLEAR MEDICINE WITH THE AID OF DESK-TOP COMPUTERS. **Feine, U.; Ehrke, F.; Knorr, D.; Kueper, K. (Univ., Tuebingen, Ger.). Electromedica: No. 2, 64-8(1970).**

The amount of digital data that must be handled each day in a nuclear medical department is so great that much time is lost despite the simplicity of the calculation in most cases. Particularly with the automatic measurements involving sample changers, the technical assistant is confronted with long columns of figures that have to be dealt with. Automatic data processing with desk-top computers in on-line operation greatly speeds up the calculation time. (auth)

58066 AUTOMATIC EXPOSURE IN TOMOGRAPHY. **Stieve, F. E. (Univ., Munich). Electromedica: No. 4, 131-5(1969).**

Fundamental considerations for obtaining satisfactory radiographs using tomographic techniques with automatic exposure timing are presented. Both conventional radiographs and those made following the administration of contrast media are discussed. It is pointed out that tomograms obtained using automatic exposure techniques provide uniform picture quality and improved homogeneity resulting from the larger effective exposure angle and the uniform transirradiation at all angles of incidence. (C.H.)

58067 STATISTICAL EVALUATION OF IMAGE IN SCINTIGRAPHY. **Baer, G. (Siemens AG, Erlangen, Ger.). Electromedica: No. 3, 235-7(1970).**

The quality of visual readability of a scintigram is determined by a number of parameters of which the maximum count rate (counts/min) found on the organ under examination, the scanning speed (cm/min) of the detector, and the count rate to be subtracted (counts/min) are especially important. These typical specifications permit a Q value to be found which gives information on the expected quality (statistical evaluation) of the scintigram to be taken. If the settings are selected in such a way that always the same statistical Q value is obtained with different scintigrams, these are necessarily of the same quality provided the other parameters, such as collimator dimensions, focus distance, and photo peak confinement are kept constant. Scintigrams taken in this manner meet the technical requirements necessary for comparison and test examinations. (auth)

Radiotherapy

Refer also to abstracts 57937, 57945, 57972, 58003, 58007–58010, 58012, 58020, 58021, 58083, 58135, 58137, 58140, 58141, 58147, 59651, and 60173.

58068 RADIATION THERAPY OF SKIN CARCINOMA. **Murphy, Walter T. (Buffalo General Hospital). J. Surg. Oncol.; 3: No. 3, 291-308(1971). (CONF-690457–1).**

From Symposium on recent advances in the management of skin neoplasms; New York, N. Y. (11 Apr 1969).

X radiation therapy of basal or squamous cell carcinomas of the skin is successful in most patients. This is true even in problem patients such as those with lesions over 10 cm in greatest diameter; lesions invading muscle, cartilage, or bone; lesions in extremities; lesions recurrent under surgical skin reconstruction; and lesions in chronic radiodermatitis. The irradiation sources should be skillfully applied by clinicians trained in the radiotherapeutic aspects of skin cancer. (auth)

58069 RADIOTHERAPY OF BRAIN TUMORS. **Okawa, Tomohiko; Miyazaki, Taiichi (Hiroshima Univ.). Hiroshima Igaku; 23: No. 8, 644-7(Aug 1970). (In Japanese).**

Brain tumors were irradiated with ^{60}Co γ rays by fixed bilateral irradiation from a Toshiba Model 107 machine. The initial dose rate was 50 R/day. This was gradually increased to 200 R/day at 2 weeks where it was maintained to give a 5000 R dose in 5 to 6 weeks. Of the total of 82 irradiated cases, 30 cases had received surgery (total and partial resection) before radiation, 52 cases were inoperable (23 cases of which had undergone low-pressure operation), and the remainder consisted of 11 cases of A-V malformation, three cases of clinical pituitary tumor, and five cases of metastatic tumor. Of these cases, 63 (76.8%) received more than 5000 R focal dose and 13 received more than 4000 R. Primary effectiveness in 52 cases given irradiation alone was rated as markedly effective in 27 cases, effective in seven cases (total of 84.6%), and ineffective in eight cases (including two cases of A-V malformation, three cases of astrocytoma, and three cases of clinical glioma). In 30 cases of postoperative irradiation, marked effectiveness was found in five cases, effectiveness in 24 cases (total of 96.6%), and ineffectiveness in only one case (an astrocytoma given 5000 R irradiation). Six-month survival rate in the irradiation alone cases was 25 out of 42 (59.5%), and for the postoperative irradiation cases it was 20 out of 24 (83.3%) making a total of 45 out of 66 (68.2%). Survival for 1 to 3 yrs was observed, but 5-yr survival cannot be calculated yet. Irradiation seemed effective for A-V malformation, and postoperative irradiation was effective for pituitary tumor. These results indicate that 5000 R may be taken as the tolerable dose for the brain. In the cases with poor results, the reason seems to be insufficiency of irradiation dose and too small an irradiated field. Examinations are required for irradiation of a large field with 6000 to 7000 R. (Japan)

58070 CLINICAL STUDIES ON THE RADIATION THERAPY IN CANCER OF THE UTERINE CERVIX. Kimura, Mitsuo (Tokyo Hospital). Gan No Rinsho; 16: No. 7, 721-36(Jul 1970). (In Japanese).

Therapeutic results are reviewed for external irradiation of uterine cervical carcinomas using super-high voltages in the Gynecology Clinic of the Cancer Institute Hospital, Tokyo. External irradiation was performed using deep x rays (1950 to 1959), telecobalt (1960 to 1963), and linac x rays (1964 to 1966). There were no significant differences among these irradiation methods for both 5-yr and 3-yr survivals, but this mode of treatment seemed significant in the case of advanced cancer. However, radiotherapy resulted in increased digestive disturbances, mainly in rectal damage, and necrosis of subcutaneous tissue. Dose analysis for intracavitary irradiation with radium indicated a close correlation between the 5-yr cure rate and the radium dose. From dose calculation points proposed by Todd and Meredish, it was found that intracavitary irradiation with standard radium of 6210 mgh at the Cancer Institute Hospital gave a dose of 5057 R (73.3 R/hr) at point A and 1331 R (19.3 R/hr) at point B. Paraconnective tissue (pelvic end) dose was analyzed in 47 cases. In the case of radium alone, the dose was distributed from 800 to 4,800 R, the average dose being 2,050 R. Radium combined with 4,600 R of telecobalt gave a dose of 5,400 to 9,400 R, with an average of 6,650 R. Lymphograms were used to standardize the range of external irradiation and to individualize the aiming of the irradiation field in paralleled opposing irradiation. The possibility for individualized treatment, rather than uniform treatment, was proved by dose calculations and individualized aiming of the irradiated field. (Japan)

58071 TANGENTIAL PENDULAR COBALT THERAPY IN THE MANAGEMENT OF BREAST CANCER. Magno, L. (Spedali Civili, Brescia, Italy). Radiol. Med.; 56: No. 11, 1060-6 (Nov 1970). (In Italian).

A technique known as tangential pendular ^{60}Co γ therapy was used for the postoperative irradiation of the chest wall and internal mammary lymph nodes following mastectomy. A group of 469 patients was treated in this way following the resection of breast tumors, often of unknown clinical stage. The great majority of the series presented histologically demonstrable axillary metastases. Assessment of the survival rates showed overall values of 74% and 58% for 3 and 5 year survivals respectively. Recurrences were observed in 54 patients (11.5%), 28 of whom died within one year. Most recurrences appeared within one year of surgery. Doses of up to 4500 rad were employed without complications. (auth)

58072 TUMOR-HOST RELATION IN CANCER RADIOTHERAPY. Oboshi, Shoichi (National Cancer Center, Tokyo). Gan No Rinsho; 16: No. 6, 651-7(Jun 1970). (In Japanese).

The basis for the effect of radiotherapy on cancer tissues is the lethal effect of radiation on cancer cells. Cancer cells destroyed by irradiation all undergo autolysis and disappear. Therapeutic effects on various cancer tissues, such as malignant lymphoma, undifferentiated carcinoma, squamous epithelial carcinoma, adenocarcinoma, and cancer tissues having necrotic foci, are slightly different but are fundamentally the same, the process being autolysis of individual cancer cells. It was revealed in radiotherapy of human cancer that the antitumor immune mechanism of the host plays an important part in addition to the lethal effect of radiation on cancer cells. Irradiation of tumor tissue results in the swelling, degeneration, and lytic disappearance of tumor cells, and numerous lymphocytic cells infiltrate between tumor cells attaching to them. This corresponds to rejection in homologous transplantation of normal or cancer tissue. Consequently, this reaction is considered to be related to the cell immunity of the host against cancer tissue, and transplantation experiments to prove this phenomenon were carried out in Donryu rats. In the actual treatment of human cancer, it is important not to injure this ability of the host for immune reaction, and to strengthen this ability by some means, although there still remains a doubtful point in this theory. (Japan)

58073 METHODS, TECHNIQUE, AND CLINICAL RESULTS WITH PREOPERATIVE RADIOTHERAPY IN 487 CASES OF BREAST CANCER. Malaspina, A. (Ospedale Maggiore, Novara, Italy). Radiol. Med.; 56: No. 11, 1055-9(Nov 1970). (In Italian).

A group of 487 patients with breast cancer in Steinthal's first three stages received preoperative conventional x and ^{60}Co γ radiotherapy. The following survival rates were observed: Stages I and II: 5 yr, 58%; 10 yr, 42%; 15 yr, 35%; Stage III: 5 yr, 26%; 10 yr, 13%; 15 yr, 2 out of 12 cases. The survival rate was much the same with the two techniques, though local and general reactions were less extensive with γ therapy. (auth)

58074 RESIDUAL LESIONS FOLLOWING EXTERNAL HIGH ENERGY RADIATION THERAPY. Kakehi, Masae; Mori, Tomoyuki; Yamashita, Nobuo; Kitagawa, Toshio (Aichi Cancer Center, Nagoya, Japan). Nippon Igaku Hoshasen Gakkai Zasshi; 30: No. 3, 296-301(Jun 1970). (In Japanese).

At the end of the course of high energy treatment of cervix uteri, there were still clinically detectable residual tumors in the irradiated area sometimes, even after a sufficient radiation dose was given. Diagnostic procedures and treatment of the residual disease were discussed resulting in the external irradiation of carcinoma of the cervix uteri in the second and third stages on two different high energy units. One hundred and fifty one cases were treated with ^{60}Co γ ray and with 6 MV x ray. Results showed that 38.4% of the cases had residual lesions including true remnant and 13.2% of the cases had true remnant at the end of the course of the external treatment. It is quite important to observe the radiation response of the irradiated lesion for at least 1.5 months for ^{60}Co and three months for 6 MV x ray after the completion of radiation treatment to detect true remnant. Additional radiation treatments were given to the residual lesions with small source irradiation in most of the cases when they were determined to be true remnant. Most of the detectable lesions were well localized at the surface of the cervix. True remnant was controlled well with 64.3% of curability. This result suggested the possibility of a radical cure of true remnant with small source irradiation and the clinical value of the small source technique was reevaluated. (Japan)

58075 TECHNICAL PROBLEMS IN THE HIGH ENERGY ELECTRON BEAM THERAPY. Mitsuta, Hideo (Osaka City Univ.). Nippon Hoshasen Gijutsu Gakkai Zasshi; 26: No. 4, 1-22(Mar 1971). (In Japanese).

The results of experimental studies on the following problems in high-energy electron beam therapy were reported: measurements of the outputs and doses—problems in conducting the measurements on the ionization type dosemeters were examined along with other dosimetry problems. Measurements of the energy—the practical range method and the radioactivating method were studied. The fabrication of simple energy checkers that utilize magnets and their applications were described. As the subject of study in regard to the dose distribution, the relations of the dose distribution to such factors as energy, scatterer, area of radiation field, and the material and shape of the treatment cone were scrutinized. Attempts were made to improve the dose distribution. Several approaches were made with the aim of extending as much as possible the range of the therapeutic capacity of the accelerators with definite upper limits on energy. The principal aims of these attempts were to increase the depth dose, and particularly, to give an effective radiation to small focus. (auth)

58076 CLINICAL AND TECHNICAL OBSERVATIONS IN THERAPY WITH 42 MeV BETATRON. Di Guglielmo, L.; Coucourde, F.; Jucker, C.; Rovera, S.; Maestro, A.; Casolo, F. (Univ., Pavia, Italy). Electromedica; No. 4, 104-10(1969).

Radiotherapy techniques used on 1028 patients treated with a 42 MeV Betatron over a three year period are described. Early results using high-energy electrons and x radiation, either separately or in combination, for the treatment of a wide variety of neoplasms are reported. (C.H.)

58077 COMMENTS ON MORBIDITY IN PRESENT-DAY RADIOTHERAPY. Kagan, A. Robert (Cedars-Sinai Medical Center, Los Angeles). Radiol. Clin. Biol.; 40: No. 4, 221-9(1971).

The relationship of biological effects in normal tissues to dose fraction factors in radiotherapy of neoplasms using supervoltage radiations is discussed. It is pointed out that the advent of supervoltage irradiation techniques has resulted in the irradiation of larger volumes of normal tissues, more intense daily radiation doses being given, and the administration of larger total radiation doses over short periods of time, and that since the area of maximum ionization is below the skin the skin reactions can no longer be used as an indication of injury of normal tissues. The additive effects of irradiation and antineoplastic drugs on hematopoietic tissues are considered. It is concluded that a radiation dose of 1,000 rad/week delivered to large tissue volumes results in injury to normal tissues and that combined chemotherapy and irradiation results in additive injury to normal tissues. (C.H.)

58078 REAL TIME DOSE DISTRIBUTION DISPLAY BY DIGITAL COMPUTER. Inamura, Kiyonari (Nippon Electric Co. Ltd., Tokyo); Otani, Shiro; Umegaki, Yoichiro; Mototake, Sakudo; Amari, Hiroko. Nippon Igaku Hoshasen Gakkai Zasshi; 30: No. 4, 315-33(Jul 1970).

The convenience of this system is to determine the optimum irradiation for each patient, by getting the figure of absorbed dose inside the body from the isodose curve, immediately after it has obtained the conditions indicated directly and easily by radiotherapists. Moreover recording of practical treatment can be performed automatically by this system. The isodose curve is obtained in about four seconds when irradiation from one port is set, and in about fifty-seven seconds by irradiation from ten ports. This system is composed of the Central Processor of NEAC-3100 Clinical Digital Computer System, Specific Input Unit and CRT Display Unit which has been specially projected, XY recorder and the other related units. The doses are calculated on the 2.5 mm interval sampling mesh points. Arbitrary isodose curves and maximum doses are displayed. (Japan)

58079 ENVIRONMENTAL CONTAMINATION WITH ^{131}I RELATED TO THE TREATMENT OF HYPERTHYROIDISM AND CARCINOMA OF THE THYROID GLAND. Blum, Manfred; Chandra, Ramesh; Marshall, Christopher H. (New York Univ., N. Y.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 57-9(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The possibility of contamination of the environment by ^{131}I excreted by patients during interstitial treatment of hyperthyroidism or thyroid carcinoma was investigated. The excretion patterns of ^{131}I (urine, feces, saliva, sweat) were examined for the possibility of contamination of the air, linens, sewage, dishes, and surfaces. It is assumed that patients are hospitalized and placed in isolation until the radioactivity has decreased. In the case of outpatients discharged with 30 mCi or less radioactivity a reasonable limit for the exposure of relatives would be the ICRP recommendation of maximum exposure of 3 rems/yr. (C.H.)

Blast and Thermal Effects

Refer also to abstract 58026.

Radiation Effects on Animals

Refer also to abstract 58034.

58080 EFFECT OF IONIZING RADIATION ON MITOTIC ACTIVITY OF CULTURED CELLS. Khamidov, D. Kh.; Khakimov, P. A.; Kolesnikova, S. S.; Mamataliev, U. (Inst. of Biochemistry, Tashkent). Uzb. Biol. Zh.; No. 2, 10-12(1971). (In Russian).

The influence of comparatively small doses of gamma radiation on the mitotic activity of human cancer cells under culture conditions was investigated. Gamma radiation doses employed were: 25, 50, 100, 300, 600 R and 3 kR, following which colchicine was added and an incubation period of 2 to 3 hr at 37°C. The radiation treatment accelerated the mitotic activity of the cells; 44% or 28% as compared with controls, depending upon the type of cells used. (K.S.W.)

58081 REPAIR OF POTENTIALLY-LETHAL RADIATION DAMAGE IN MAMMALIAN CELLS: ENHANCEMENT BY CONDITIONED MEDIUM FROM STATIONARY CULTURES. Little, J. B. (Harvard Univ., Boston). Int. J. Radiat. Biol.; 20: No. 1, 87-92(1971).

Cultures of Chang human-liver cells and Chinese hamster cells (V-79) were x-irradiated during the stationary phase at a dose rate of 100 R/min at room temperature. Survival curves are presented for cells from stationary-phase cultures exposed to trypsin and sub-cultured 0, 6, and 12 hrs after irradiation and for exponentially growing cells incubated for 6 hrs after irradiation with conditioned media from stationary cultures. Cultures of exponentially growing cells were also incubated for 6 hrs after irradiation with a 50-50 mixture of fresh and conditioned media and ultimate survival compared with that in cultures incubated with either medium. In 11 experiments in which cultures of liver cells were given single doses of 800 to 1600 R, the survival of cells incubated with the 50-50 mixture was variable, but consistently greater than that of control cells and generally approaching that of cells incubated with conditioned media. The activity was destroyed by incubation for 1 hr at 56°C but insensitive to DNA-ase and RNA-ase. Results suggested that Chang liver cells release a diffusible substance into the medium promoting the repair of potentially lethal radiation damage. Experiments with Chinese hamster cells exposed to 2000 R, where survival was only slightly enhanced by post irradiation incubation in a mixed medium, suggested that medium depletion may have been a significant factor. (UK)

58082 GROWTH INHIBITION AND RADIOSENSITIZATION OF 5-FLUOROURACIL IN CULTURE OF HeLa CELLS. Moriki, Toshio (Mie Prefectural Univ., Tsu, Japan). Mie Med. J.; 19: No. 3, 263-75(Jan 1970).

Cytological and radiobiological properties of HeLa cells after treatment with 5-fluorouracil (5FU) are described. Treatment with 5FU inhibited cell growth at doses of more than 0.5 μg/ml, even at 5 μg/ml for 30 min. Treatment at 5 μg/ml for 24 hrs reduced the mitotic index, and after removal of the drug, induced a peak in the mitotic index of 7% 24 hrs later. The formation of polynuclear cells of 45% occurred 48 hrs later. The drug caused the cells to accumulate at the S phase by the incomplete inhibition of DNA synthesis without affecting the other mitotic processes during the treatment. After removal of the drug, the blocked cells entered into the G_2 phase and were blocked again at the S stage. The radiosensitizing effect of the inhibitory action on cell growth was found during the combined treatment of the cells with 0.05 μc/ml 5FU for 24 hrs followed by exposure to 35 ergs/mm^2 of uv radiation. Unscheduled DNA synthesis was enhanced by at least a factor of 2 by treatment with 5 μg/ml 5FU for 24 hrs in combination with 70 ergs/mm^2 of uv irradiation. Unscheduled DNA synthesis was further enhanced by partial irradiation with an uv microbeam of one-half of the nuclear component. The rate of DNA synthesis was dependent upon the dose of 5FU, and was virtually independent of the dose of uv light. (auth)

58083 EXPERIMENTAL STUDY OF THE EFFECTS OF X RAYS AND ELECTRONS ON MALIGNANT TUMORS. Hasegawa, Susumu (Tokyo Medical Coll.). Tokyo Ika Daigaku Zasshi; 27: No. 6, 811-32(Nov 1969). (In Japanese).

The effects of x-ray and electron beams on Takizawa's sarcoma and Yoshida's sarcoma were investigated in vivo, and observations were made on the transplantation rates and the growth-rate of the tumors. Irradiated Takizawa's sarcomas developed at the lateral, femoral, and subcutaneous regions of mice were extracted and transplanted to those regions of other healthy mice. When the size of the grown tumor was more than 25 mm^2, the tumor was regarded as a positive transplantation. X-ray administration was made in doses of 1000 to 3000 R under an x-ray voltage of 150 kVp, while betatron was administered in doses of 801 to 2883 rads at 26 MeV, each a single and total irradiation dose. Positive transplantation was observed in 100% of the cases at doses up to 1500 R, in 60 to 85% at 2000 R, in 45 to 50% at 2500 R, and in 0% at 3000 R. In the case of electron beam irradiation, positive transplantation was observed in 100% of the cases at doses up to 1602 rads, in 95 to 100% at 2002 rads, in 70 to 80% at 2403 rads, and in 0% at 2883 rads. The size of the tumor was 179 mm^2 on an average in the 2nd week in the 1000 R irradiation group. When comparing this group as 100% with other groups, the 1500 R group showed 77% and the 2500 R group showed 37%. In rats with Yoshida's sarcoma, the x irradiation group showed a 100% positive rate of transplantation up to 2000 R and 30% at 3000 R. In the cases of betatron irradiation, the positive transplantation rate was 100% up to 1602 rads, 80% at 2403 rads, and 0% at 3204 rads. The size of the tumor was 170 mm^2 on an average by the 10th day in the 1000 R x irradiation group. When this group as 100% was compared with other groups, the 2000 R group showed 85% and the 3000 R group showed 44%. The cases of electron beam irradiation showed nearly similar results to those of x irradiation. (auth)

58084 MECHANISM OF INTERPHASIC DEATH IN RADIATION DAMAGE. PHOTOREACTION FOLLOWING ULTRAVIOLET MICROBEAM IRRADIATION AT A NUCLEAR AND CYTOPLASMIC PART OF LIVING CELLS. Karitani, Yoshiaki (Mie Prefectural Univ., Tsu, Japan). Mie Med. J.; 19: No. 3, 277-94(Jan 1970).

The nuclear or cytoplasmic portion was exposed, mainly to a uv microbeam of 2 μ square, in cultured HeLa cells and in vitro human blood leukocytes and newt peritoneal macrophages and some radiocytological properties were observed. Morphological photoreactions in the irradiated nuclei were divided into two types. One type was typically demonstrated in HeLa cells. The irradiated portion was seen as a dark area by dark phase optics, where DNA and basic protein aggregated, and the typical case was seen in newt cells and human blood leukocytes, where the irradiation induced a pale area at low doses, but produced a dark core in its center at high doses. The latter core showed a positive reaction for basic protein by toluidine blue staining at pH 6.0, but was negative in uv absorption. Interphasic death was much more frequently induced by the partial irradiation of the nucleus than by irradiation of the cytoplasm. The irradiated lysosomes in the Golgi area did not show any significant change in dark phase microscopy and acid phosphatase staining, even following partial irradiation with a 15 μ microbeam spot at high doses. In HeLa cells vitally stained with neutral red (3 × 10^4), the irradiated lysosomes shed the dye into the medium in a short time or immediately after irradiation. Thereafter, the decoloration spread widely to all lysosomes and the cells were rapidly killed. Corresponding to the decoloring part of the lysosomes in a vital state, a non-, weak, or diffuse staining part appeared in the acid phosphatase stain of the lysosomes. Mechanisms of interphasic death induced by partial irradiation of the nucleus and in the vitally stained cytoplasm are discussed. (auth)

58085 ELECTRON MICROSCOPIC STUDY OF RADIATION EFFECTS ON CULTURED CELLS WITH DIFFERENT RADIOSENSITIVITIES. Kasuga, Tsutomu; Furuse, Tekeshi; Tsuchiya, Eiko; Takahashi, Ichi (National Inst. of Radiological Sciences, Chiba, Japan). Gan No Rinsho; 16: No. 6, 639-50(Jun 1970). (In Japanese).

Radiosensitivity of cells can be determined from the colony-forming rate, i.e., plating efficiency. In addition, damage to the constitutional elements of cytoplasm is expected to become a factor that controls radiosensitivity of a cell, as well as its mitotic death. Using such hypotheses, comparative examinations were made on two radiation resistant cell cultures showing different reactions to radiation, using melanoma strain B-16XI (isolated from a transplantable mouse melanoma) ($n = 6.5$, $D_q = 285$ R) and HeLa S3 strain ($n = 2.7$, $D_q = 140$ R, $D_0 = 150$ R), based on electron microscopic and histochemical (acid phosphatase reaction) observations. The radiation source was 200 kV, 20 mV x-ray, giving a single irradiation of 1000 R from a distance of 50 cm, the dose rate being 100 R/min, and half-value layer of 0.3 mm Cu + 1.0 mm Al. The most marked differences between these two strains of cells were confirmed by degeneration of mitochondria in irradiated HeLa S3 cells, accompanied by periodical increase of autophagosomes and their behavior, and by the behavior of markedly increased pinocytotic vesicles and microvesicles in irradiated melanoma cells. The present results suggest that the difference in radiosensitivity between HeLa S3 cells and melanoma cells is probably correlated to the difference in all the metabolic functions and activities possessed by the two strains of cells. (Japan)

58086 DEATH OF CULTURED MAMMALIAN CELLS FROM TRITIUM DECAY. SUICIDE EXPERIMENT. Okada, Shigefumi (Tokyo Univ.). Radioisotopes (Tokyo); 19: No. 12, 614-21 (Dec 1970). (In Japanese).

Experiments on the effects of beta decay of tritium on cultured mammalian cells were conducted for studies on the mechanism of cell death. A concentration of less than 2 μCi/ml of tritiated thymidine was administered to cell cultures for more than 10 hr. With one-cycle labeling, only the single strand of DNA was labeled (unifilar labeling) and both strands were labeled (bifilar labeling) when the cells were in contact for more than four cycles. In order to obtain a uniform rate of incorporation of tritiated thymidine into newly synthesized DNA, 10^{-4}M thymidine and 10^{-5}M deoxythymidine were added to the culture medium. The efficiency of beta decay of one tritium atom for killing a cell was 0.006 in unifilar labeled cells and 0.0125 in bifilar labeled cells. The survival curve of unifilar labeled cells was exponential whereas that of bifilar labeled cells was sigmoidal. The beta dose to a nucleus of 3μ radius was calculated to be 0.5 rad per decay. The beta dose corresponding to D_{37} (175 decays/cell) was ca 90 rads in unifilar labeled cells and about 40 rads in bifilar labeled cells. It was concluded that much DNA damage was required to kill the cell and that transmutation of tritium to helium-3 by liberation of beta particles and movement of the ^{3}He nucleus by recoil also played an important role in the death of a cell. (Japan)

58087 COMPARATIVE EFFECT OF HYDROCORTISONE AND CYCLIC AMP ON THE MULTIPLICATION OF CULTURED CELLS (KB STEM) AND THEIR SURVIVAL AFTER ULTRAVIOLET IRRADIATION. Aujard, Colette (Centre National de la Recherche Scientifique, Villejuif, France). Compt. Rend., Ser. D; 272: No. 26, 3340-3(28 Jun 1971). (In French).

It is shown that cyclic AMP inhibits the multiplication of KB cells, as does hydrocortisone, but that in contrast to the hormone, this substance does not favor the survival of KB cells subjected to an aggression such as ultraviolet irradiation. (France)

58088 INFLUENCE OF RECOVERY FROM SUBLETHAL DAMAGE ON THE RESPONSE OF CELLS TO PROTRACTED IRRADIATION AT LOW DOSE-RATE. Fox, Margaret; Nias, A. H. W. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Curr. Top. Radiat. Res.; 7: No. 1, 71-103 (Sep 1970).

The nature of physical and chemical factors affecting recovery from sublethal damage in mammalian cells is discussed and evidence presented to show that it is not correlated with repair replication. Reduction of dose-rate to a biological system results in reduced cell killing; such effects are described and the influence of environmental factors discussed. In most mammalian systems previously described analysis of the contribution of recovery from sublethal damage is complicated by continued cell proliferation. It is suggested that irradiation of cells at low dose-rates at room temperature can provide a clearer picture provided that plating efficiencies remain high. At dose-rates of 30 to 40 rad per hour there is a decreasing proportion of survivors in the population. If dose-rates are reduced to about 10 rad per hour, then a steady state situation can be achieved where death rate per cell cycle does not exceed birth-rate, and the population will survive indefinitely. The kinetics of this situation are discussed. The width of the shoulder on the acute dose response curve is a good indication of the sensitivity of a cell line to low dose-rate irradiation and it is suggested that the maximum dose tolerated per cycle in steady state is a good indication of the efficiency of the repair system for sublethal damage. (auth)

58089 DAMAGE AND REPAIR PROCESSES RELATIVE TO NEUTRON (AND CHARGED PARTICLE) IRRADIATION. Elkind, M. M. (Brookhaven National Lab., Upton, N. Y.). Curr. Top. Radiat. Res.; 7: No. 1, 1-44(Sep 1970).

Of the high linear energy transfer radiations of practical import, fast neutrons are currently receiving considerable attention. This stems mainly from their potential usefulness in connection with the treatment of tumors in view of the reduced oxygen effect associated with high linear energy transfer radiations. However, interest in the radiobiology of fast neutrons as well as charged particle beams derives also from the expected growth of atomic power and a need to understand the hazards to man during flights in space. Repair processes are now recognized to have a major bearing on the degree of radiation damage expressed and therefore the dependence of the effectiveness of such processes on radiation quality must be understood. In this review, the dependence of sublethal damage repair is examined to the extent that available data permit. Starting with x rays, for which the data are extensive, fractionation experiments performed with charged particle as well as fast neutron beams are examined in order to help develop a general appraisal of the dependence of repair on the rate of linear energy transfer. While the experiments analyzed refer exclusively to mammalian cells, because of the limited data available with any one cell system, and in order to identify generalities, results from a variety of sources are reviewed. Finally, some initial data relative to the damage to DNA produced by 14 MeV neutrons are also considered relative to the possibility that the targets sensitive to densely ionizing radiation may not be the same as those sensitive to radiation like x or γ rays. (auth)

Invertebrates

Refer also to abstracts 57939, 57959, 57961, 57962, 57966, and 58161.

58090 RADIOSENSITIVITY OF GERMINAL AND SOMATIC CELLS OF THE HERMAPHRODITE GONAD OF ASTERINA GIBBOSA PENN FOLLOWING X IRRADIATION. ULTRASTRUCTURAL STUDY OF DIFFERENTIAL RADIOLESIONS. Brusle, Jacques (Faculte des Sciences, Orleans, France. Faculte des Sciences, Orsay, France). Arch. Biol. (Liege); 80: 451-70 (1970). (In French).

X irradiation of hermaphrodite gonads of Asterina gibbosa confirmed the existence of two germinal strains, whose differential radiosensitivity was clearly distinct. The spermatogenic lineage was more fragile than the ovogenetic one; with equal irradiation doses, spermatogonic and spermatocytic radiolesions appeared earlier and were more intense than those of ovogonies and ovocytes. The results of x irradiation did not yet allow the assumption that the differential threshold of alterations and behavior exists from the very first stages of cell differentiation within each lineage. With the doses tested, no other difference of sensitivity was detected, which might imply the existence of undifferentiated cells or gonies. The sole radioresistant somatic cells observed in the gonads was the follicular and phagocytic cells. The germinal epithelium was definitely lacking. (auth)

58091 ACTINOMYCIN D: ITS DUAL ROLE IN RADIOPROTECTION AND RADIOSENSITIZATION TO GAMMA RADIATION IN TETRAHYMENA. Mossman, K. L.; Whitson, G. L. (Univ. of Tennessee, Knoxville). Radiat. Eff.; 10: No. 1-2, 9-15(Jul 1971).

Log phase cells of Tetrahymena pyriformis, HSM, were exposed to various combinations of Actinomycin D and γ radiation. At low concentrations, Actinomycin D acted as a protective agent to ionizing radiation, whereas at high concentrations this drug sensitized cells to γ rays. Analysis of growth curves indicated that delays in growth in log phase cultures were obtained after cells were first pretreated with Actinomycin D (15 μg/ml) and then exposed to 80,000 rads of γ rays. At low concentrations, Actinomycin D (2 μg/ml) produced no growth delays in cells exposed to the same dose of γ rays. Studies on the rate of RNA synthesis in log phase cells treated with Actinomycin D indicated that at low concentrations little, if any, RNA synthesis was inhibited, whereas a decrease in RNA synthesis was observed at the high concentrations of this same drug. Further studies on the stability of total cellular RNA, when synthesis was depressed by Actinomycin D, indicated that very little degradation of this nu-

XU

cleic acid occurred following large doses of ionizing radiation. On the other hand, the stability of DNA in cells was affected in cells exposed to ionizing radiation and in cells pretreated with Actinomycin D and then exposed to ionizing radiation. Ionizing radiation, alone, resulted in some breakdown of DNA and cells pretreated with Actinomycin D (20 μg/ml) resulted in more degradation of DNA. (auth)

58092 INFESTATION OF IRRADIATED WHITE OAKS BY THE SOLITARY OAK LEAFMINER, CAMERARIA HAMADRYADELLA (LEPIDOPTERA: GRACILARIIDAE). **Hinckley, A. Dexter (Brookhaven National Lab., Upton, N. Y.). Ann. Entomol. Soc. Amer.; 64: No. 5, 1094-8(15 Sep 1971).**

On isolated shoots of white oak exposed to 20–30 roentgens per day in 2 gradients of gamma irradiation, solitary oak leafminer, Cameraria hamadryadella (Clemens) (Lepidoptera: Gracilariidae), densities (sample means for 2nd-generation mines per 100 leaves and standard errors of the means) were 220 ± 33 in 1967, 167 ± 67 in 1968, and 16 ± 4 in 1969. During the same years, on white oaks exposed to less than 3 roentgens per day, the densities were 48 ± 7, 35 ± 5, and 3.8 ± 1.7 for leaves on branches 1–3 m high and 20 ± 2, 9.1 ± 1.1, and 1.0 ± 0.2 for leaves collected on the ground. (auth)

58093 HISTOPATHOLOGICAL STUDIES ON IRRADIATED AND CHEMOSTERILIZED BEET LEAFHOPPERS, CIRCULIFER TENELLUS. **Ameresekere, R. V. W. E.; Georghiou, G. P.; Sevacherian, V. (Univ. of California, Riverside). Ann. Entomol. Soc. Amer.; 64: No. 5, 1025-31(15 Sep 1971).**

The internal morphology of the reproductive system of Circulifer tenellus (Baker) is described. Morphological, as well as histological, changes resulting from exposure of nymphs and adult males and females to ^{60}Co irradiation, or treatment by N,N′-hexamethylenebis(1-aziridinecarboxamide) are discussed. Primary egg chambers with developing oögonia, oöcytes, and follicle cells are present in 12-hour-old females. Females exposed to 5 kr irradiation showed only a reduction of various cell stages of oögenesis, but 10 kr dosages caused nuclear disintegration and cellular atrophy. Similar effects were observed in chemosterilized individuals, nymphs being more sensitive than adults. Treatment of males with 20-kr dosages resulted in pronounced cell necrosis and sperm depletion. (auth)

58094 RESTORATION EFFECT OF ECDYSONE AFTER THE ARRESTING OF POST-EMBRYONIC DEVELOPMENT OF γ-IRRADIATED CERATITIS CAPITATA WIED LARVAE (TRYPETIDAE DIPTERONS). **Çals-Usciati, Josette (Univ., Paris). Compt. Rend., Ser. D; 272: No. 26, 3295-8(28 Jun 1971). (In French).**

The re-establishment of the formation of puparia by injecting ecdysone into the permanent larvae, obtained by γ radiation, established the radiorestoration action of ecdysone. (France)

58095 EFFECT OF X IRRADIATION OF THE HEAD ON NEUROSECRETORY CELLS IN GRYLLUS DOMESTICUS L. **Theodorescu, M. (Bucharest Univ.); Novak, V. J. A. Acta Entomol. Bohemoslov.; 67: No. 4, 207-10(1970). (In French).**

The head of the last instar nymphs was irradiated 1 and 4 days after moulting with doses ranging from 100 to 500,000 R. Paraffine sections of the brain and thoracic ganglia stained with paraldehyde fuschsine were investigated as to the degree of the induced injury. The structural state of the cells, amount of neurosecretion and its disposition in the neurons and axons, and the nucleocytoplasmic relation were ascertained. Only the motility of the insects was affected and distinct morphological changes took place following irradiation with 500,000 R. The state of the neurosecretory cells was compared with that of the average nerve cell. (NSA of Czech)

58096 MORPHOLOGY AND DEVELOPMENT OF THE MACRONUCLEI OF THE CILIATES STYLONYCHIA MYTILUS AND EUPLOTES AEDICULATUS. **Ammermann, Dieter (Univ., Tuebingen, Ger.). Chromosoma; 33: 209-38(1971).**

Some stages of macronuclear anlagen development, known from earlier investigations, were studied in detail. The results are: The giant chromosomes of Stylonychia mytilus are not somatically paired, but are connected end-to-end to form one or a few composite chromosomes. When they later disintegrate, the bands become isolated granules. Spectrophotometric measurements show that during the DNA-poor stage which follows the disintegration of the chromosomes, the macronuclear anlagen of Euplotes have a DNA content of 21 c, while the syncaryotic (deriving from syncarya) and hemicaryotic (deriving from haploid hemicarya) anlagen of Stylonychia have the DNA content of diploid micronuclei. Nevertheless the syncaryotic anlagen of Stylonychia and Euplotes initially develop two nucleoli at the end of this stage, the hemicaryotic anlagen of Stylonychia only one. From this it is concluded that the genes of one giant chromosome band stay together in one granule. Labeled DNA from the giant chromosomes which remains in the anlagen during the DNA-poor stage is distributed approximately equally to the daughter nuclei during the first few fissions of the exconjugants. Autoradiographic experiments showed that the DNA of the macronuclei of Stylonychia that is duplicated at one time in a replication band is not duplicated simultaneously during the next DNA-duplication. The DNA duplications during the second polyploidization stage of the macronuclear anlagen development are exceptions, because the mixing of the macronuclear DNA which occurs before every fission does not occur during the second polyploidization stage. The pseudomicronuclei which sometimes are formed from the macronuclei in emicronucleated strains of Stylonychia contain numerous elements which are much smaller than the chromosomes. The macronucleus of Stylonychia is very insensitive to irradiation with x-rays. The results lead to the following hypothesis: The macronuclei of the two hypotrich ciliates contain unconnected chromomeres or small aggregates which are distributed at random to the two daughter nuclei during the divisions. (auth)

Vertebrates

Refer also to abstracts 57929, 57932, 57933, 57936, 57944, 57967, 57997, 58033, and 58036.

58097 (ORNL-tr-2521) TUMORS OF ALBINO RATS OF VARIOUS AGES AFTER SINGLE TOTAL-BODY ROENTGEN IRRADIATION. **Reincke, U.; Stutz, E.; Wegner, G. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Z. Krebsforsch.; 66: 165-86(1964). 32p. Dep. NTIS.**

Four groups of male and female Wistar rats received a single total-body x irradiation of 270 R, at 5 days before birth and 13, 49, and 121 days after birth. A fifth group consisted of gravid females 121 days old. A sixth group was composed of non-irradiated control animals. The 30 day mortality after prenatal irradiation was 44% and after post-natal irradiation between 0 and 9%. The animals that survived intrauterine irradiation often showed growth retardation, and in over 90% of the autopsies there was microencephaly, usually combined with unilateral or bilateral microphthalmia. In addition, there was hypoplasia of the genital organs of both sexes. In all the irradiated groups the life expectancy was reduced about three to six months. It was not influenced, however, by the age at which they were exposed to irradiation. In 512 irradiated and autopsied animals, 402 benign and malignant tumors were diagnosed histologically. Among the 118 controls 44 tumors were found. In the irradiated males the number of malignant tumors was increased up to 10 times the rate of spontaneous tumors, and in the irradiated females up to four times. The benign tumors in the male animals did not increase after irradiation, however, in the females they were very considerably increased due to the frequency of breast and ovarian tumors. (auth)

58098 EFFECT OF LOW X-RAY DOSES ON THE CENTRAL NERVOUS SYSTEM. RESEARCH FOR TESTING THE ROLE OF DISTANCE AND TO ESTABLISH THE RATIO BETWEEN NEURONAL HISTOPATHOLOGICAL ALTERATIONS AND NUCLEIC ACID HISTOCHEMICAL ALTERATIONS; ACUTE CELLULAR DISEASE-INDUCED NEURONAL ALTERATIONS AND SEVERE CHRONIC CELLULAR DISEASE ALTERATIONS; NEURONAL AND EXTRANEURONAL ALTERATIONS. **Vasculescu, Tr.; Pasculescu, Gh. Oncol. Radiol.; 9: No. 6, 551-60(1970).**

Experiments were performed on 98 rats killed 1, 6, 24, and 48 hrs and 1, 6, and 20 weeks after irradiation of the central nervous system with a single dose of 30 R; 10 R/m; 160 kV; 0.5 Cu + 0.5 Al at 100 cm and 40 cm respectively focal distance from the skin. It was found that radiation injuries increased with distance. A biphasic aspect of neuronal modification dynamics and the causal ratio between RNA cytoplasmic alterations (fall or precipitation) and acute or severe chronic disease-induced histopathological changes were emphasized. Determinations of acid phosphatase enabled one to conclude, simultaneously with the acute cellular disease alterations (fall of cytoplasmic RNA), on an increase of lysosome permeability. Though some of these aspects are apparently significant, yet causal relations between neuronal acute and chronic modifications on the one hand, and neuronal changes, haemodynamic or extraneuronal changes in general, on the other, could not be established. (Rom. Sci. Abstr.)

58099 SPECIFICITY OF INCREASED RESISTANCE OF ANIMALS TO REPEATED ACTION OF RENAL POISONS. **Vaksberg, G. M. Patol. Fiziol. Eksp. Ter.; 14: 31-3(Jul-Aug 1970). (In Russian).**

Rabbits and rats were subjected to repeated and cross poisoning with uranium and mercuric bichloride. Examination of residual nitrogen in the blood demonstrated that increased animal resistance to repeated poisoning occurred only when the same poison (uranium or mercuric bichloride) was administered. Residual blood nitrogen increased after each poisoning, regardless of the order of administration of uranium and mercuric bichloride to the animals. Antigens absent in normal animals were revealed in experiments on guinea pigs (in their kidneys and liver) with the aid of reaction of anaphylaxis with desensitization. (auth)

58100 OPERANT BEHAVIOR OF PRE- AND POST-PUBERTAL RATS IRRADIATED WITH ^{131}I IN THE LAST TRIMESTER OF GESTATION. **Bogdanove, L. H.; Doody, A.; Nadackapadam, X. (Dept. of Pharmacology, Chicago). Experientia; 27: No. 8, 907-8(15 Aug 1971).**

Rats were injected intraperitoneally with iodine-131-labeled sodium iodide on the fourteenth day of gestation. The irradiation induced varying degrees of thyroid destruction in mother and siblings and decreased ratios of iodine labeled protein; inorganic iodine in mothers, compensatory hyperactivity in thyroids of siblings, and increased perseverance of operant behavior which decreased with maturation. Changes observed in siblings were not fully accountable by either differences in labeled iodide thyroid uptake, serum protein binding or thyroid histology. (H.L.W.)

58101 VVEDENSKII'S FREQUENCY PESSIMUM AFTER IRRADIATION OF THE SPINAL CORD. **Semagin, V. N. (Inst. of Higher Nerve Activity and Neurophysiology, Moscow). Dokl. Akad. Nauk SSSR; 197: No. 6, 1452-5(21 Apr 1971). (In Russian).**

Orthodromic responses were recorded from crosscut ventral roots during electrical irritation of the crosscut dorsal roots of the lumbar branch of the spinal cord of 37 non-narcotized rats. Rhythmic irritation proceeded at the intervals: 5, 10, 20, . . ., 100 sec. X-irradiation of the spinal cord was conducted on 28 ambulatory rats at a dose of 1000 R. Mono- and polysynaptic responses of controls and irradiated mice were noted. The results are tabulated and discussed. (K.S.W.)

58102 EFFECT OF X-RAY OR GAMMA-RAY IRRADIATION ON RAT TIBIA. **Murakami, Eisuke (Kyushu Univ., Fukuoka). Kyushu Ketsueki Kenkyu Dokokaishi; 20: No. 2, 159-96(Jun 1970). (In Japanese).**

The effect of x rays (250 kVp, HVL = 1.45 mm Cu) or ^{60}Co gamma rays on the bone and bone marrow of young female rats was studied. Each irradiated group was subdivided into four groups according to dose (1500 R, 3000 R, 5000 R, and 7000 R in a single dose). On roentgenographical observation, the stunting of longitudinal growth of the tibia irradiated with 3000 R of x rays or gamma rays was more prominent than that of the tibia irradiated with 1500 R. Comparing the stunting of longitudinal growth of x-irradiated tibia with that of gamma-irradiated tibia, the former were more prominent than the latter. On microscopic examination of the control group, the mean value of thickness of the proximal growing epiphyseal plate of tibia irradiated with 3000 R or 5000 R of x rays or gamma rays increased gradually. Histopathologically, the epiphyseal plate of tibia that were subjected to 1500 R of x rays or gamma rays revealed degeneration of the columnar cartilage cells at 3 days after irradiation. It regained completely its original hematopoietic activity at 10 days after irradiation. Those irradiated with 5000 R and 7000 R, in a single dose, of x rays or gamma rays became aplastic with edematous changes. Fracture and/or disruption also occurred at 5000 R or 7000 R in both cases during 2 to 12 months. Neoplasms were also seen, e.g. spindle cell sarcoma, osteoplastic osteogenic sarcoma, and squamous cell carcinoma. The extent of injury from x rays to the bone tissue and the growing epiphyseal plate was greater than that from gamma rays, but there was no qualitative difference of biological injuries induced by x rays and gamma rays. (Japan)

58103 PARTICIPATION OF X-RAYED CELLS IN A REGENERATE INDUCED ON AN X-RAYED LIMB OF THE SALAMANDER, TRITURUS VIRIDESCENS. **DeSha, David Lawrence. New Orleans; Tulane Univ. (1971). 78p. University Microfilms Order No. 71-20,218.**

Thesis.

The purpose of the present study was to determine whether or not x-irradiated cells can participate in regeneration. It was necessary to produce labeled x-rayed cells so that their movements could be traced. Labeled, irradiated cells were obtained in the following manner. Tritiated thymidine was injected intraperitoneally into animals with regenerating right forelimbs. Cells in the regenerate which differentiated, and soon ceased to divide, were labeled and remained labeled for long periods. The limb regenerated with labeled tissues subsequently was x-rayed with 2000R, and unirradiated hind limb skin was transplanted to the x-rayed forelimbs to induce regeneration. As controls against spontaneous regeneration, some of the x-rayed limbs with labeled internal tissues merely were amputated. Regenerates were produced on the x-rayed limbs supplied with grafts, and only small nubbins of tissue accumulation were found in the control limbs. These nubbins often regressed. Histological studies of the x-rayed limbs supplied with a graft indicated that labeled x-rayed cells were released from the internal tissues near the amputation surface and were incorporated into the blastema. These cells presumably formed a portion of the differentiated tissues of the regenerate. Studies were performed to verify that the labeled cells observed in the regenerates on the x-rayed limbs were from x-rayed internal tissues and were not from extraneous sources. It can be concluded from this study that 2000R of x-irradiation blocks salamander limb regeneration; that transplantation of unirradiated tissues to the limb can overcome the effects of irradiation; and that x-rayed cells can participate in regeneration of the x-rayed limbs. Thus, it appears that x-irradiation of limbs does not block the ability of some x-rayed cells to contribute to a regenerating system; and therefore, it is not a reliable method of determining which individual tissues or cells contribute to the formation of the blastema. (Diss. Abstr. Int., B)

58104 SERUM CONCENTRATIONS OF THREE IMMUNOGLOBULIN CLASSES IN PIGS AFTER EXPOSURE TO A γ-RAY DOSE OF 1600 RADS. **Bazin, H.; Daburon, F.; Vaerman, J. P.; Heremans, J. F. (Dept of Experimental Medicine, Brussels). Int. J. Radiat. Biol.; 20: No. 1, 93-5(1971).**

Data are presented giving the serum concentration of immunoglobulins IgM, IgA and IgG in 9 pigs, during 6 days after γ-irradiation with doses of 1600 rads. The only significant change was an increase in serum IgA. (UK)

58105 SHORT-TERM KINETIC STUDIES ^{18}F UPTAKE IN NORMAL, X-IRRADIATED, AND FRACTURED BONE. **Lamel, David Arthur. Los Angeles; Univ. of California (1971). 162p. University Microfilms Order No. 71-19,456.**

Thesis.

Previous short-term kinetic studies of "bone-seeking" isotopes concentrated on calcium and strontium. The radioactivity as a function of time curves obtained with an external detector placed over a particular site of interest during the first hour following intravenous injection of a radioactive tracer, were labeled "osteograms". Osteograms obtained with the current isotope used for bone scanning, fluorine-18, had not been investigated. Techniques were developed for obtaining good quality osteograms using fluorine-18. These methods were effective in both controlled, laboratory animal experiments, and in everyday applications in a hospital clinic. Using a large computing system, the osteograms were described in the following mathematical form: $\mathrm{OTS/MIN}(t) = 1 \pm A_1 \cdot e^{\pm B_1 \cdot t} \pm A_2 \cdot e^{\pm B_2 \cdot t} \pm A_3 \cdot e^{\pm B_3 \cdot t}$. Physiological meanings of the three exponential terms were postulated: mixing of the radioactive tracer with the blood, movement of the tracer through the extravascular spaces, and incorporation of the tracer within the crystalline portion of the bone. A series of osteograms of the tibiae of "normal" laboratory rabbits was obtained. In addition, osteograms of the following abnormal conditions were studied: fracture of the tibia, sham fracture of the tibia, x-irradiation of the tibia, and x-irradiation plus fracture of the tibia. While sham fracture osteograms showed no deviations from normal patterns, the fracture osteograms indicated a large increase in the mineralization rate. The effect of 2000 rads of x-irradiation to the tibia was to suppress mineralization, with the result that irradiated fractures would not heal, at least during the ten weeks following fracture. The fracture osteograms, both with and without x-irradiation, exhibited an increased importance of the exponential term associated with tracer movement within the extravascular spaces. Neither the sham fracture osteograms or the x-irradiation osteograms displayed the phenomenon. (Diss. Abstr.)

58106 X-RAY INDUCED INCREASE IN NUMBER OF CYSTEINE-RICH PERIVENTRICULAR GLIAL CELLS IN THE RAT BRAIN. **Srebro, Z. (Inst. of Biomorphology, Krakow). Experientia; 27: No. 8, 945-7(15 Aug 1971).**

X radiation was administered in doses of 1000 to 4000 R to the head region of 58 rats, the remainder of the body being shielded with lead. The animals were killed on the 7th, 14th, or 21st post-irradiation days and the brains examined histologically. Fifty per cent of the animals given 3000 and 4000 R died before the 7th post-irradiation day; the surviving animals of these groups showed considerably higher numbers of the cysteine-rich glial cells in the brains than rats of other groups. The significance of the results is discussed. (H.L.W.)

58107 ACTION OF GAMMA RADIATION ON THE ADRENAL CORTEX AND THYROID GLAND IN THE RAT. **Pegel, V. A.; Dokshina, G. A.; Potapova, A. I. (Science Research Inst. of Biology and Biophysics, Tomsk, USSR). Izv. Sib. Otd. Akad.**

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Nauk SSSR, Ser. Biol. Nauk; 3: No. 15, 124-7(Dec 1970). (In Russian).

The effect of high-energy betatron radiation on some endocrine systems on the rat was investigated. White rats of both sexes were subjected to 25 MeV quanta at 50 Rad/min for a total dose of 1000 Rad. Acute radiation sickness developed on the second day, and the animals subsequently lost considerable weight. 11-hydroxycorticosteroids were measured in the blood plasma, and glandular functions were evaluated in the standard manner. Blood leucocytes decreased rapidly in number following irradiation whereas plasma steroid content increased. It was concluded that the effect of radiation was an increase of adrenal cortex activity, and a depression of the thyroid activity. (K.S.W.)

58108 STUDY OF WEIGHT CHANGE OF THE SPLEEN FOLLOWING FRACTIONATED IRRADIATION IN MICE. Yasukochi, Akira (Kyushu Univ., Fukuoka). Fukuoka Igaku Zasshi; 61: No. 6, 359-75(Jun 1970). (In Japanese).

Changes of spleen weight following fractionated whole-body irradiation were studied in mice. Mice were irradiated with 190 kVp x rays and ^{60}Co γ rays in two equal fractionations at 0, 1, 3, 6, and 10 day intervals (zero day interval meant single exposure). The exposure dose that reduced spleen weight was measured on the 4th day after the second irradiation. The exposure dose for fractionation of 3 day intervals was almost equal to that of a single exposure and smaller than that of other groups for 50% reduction of spleen weight. The equal effect ratio of ^{60}Co γ rays to 190 kVp x rays was 0.7 to 0.8 on the basis of the result mentioned above. Mice were exposed to 364 rad γ rays in different types of fractions, (0, 1, 2, 3, 4, and 6 day intervals). Spleen weight showed a fluctuation in groups of 2 and 3 day intervals, reaching the minimum value at 1 to 2 days followed by a slight recovery and then a second phase of decrease of weight at 5 days after the second irradiation. Gradual recovery of spleen weight to that of control followed. In order to elucidate the cause of the bi-phasic change of spleen weight, further experiments were performed. All experimental groups of mice were exposed to 364 rad, but different fractionations were given to each group to check whether the first or second irradiation had the primary effect on the change of spleen weight. All groups showed more or less similar pattern of change of spleen weight, but this pattern was most markedly seen in the groups to which smaller doses were given on the second irradiation, as in the groups of 8 : 2 and 9 : 1 fractionation. Histological studies showed no significant findings to explain this bi-phasic type of change of spleen weight. (auth)

58109 MUTUAL EFFECTS OF SUBLETHAL HEMORRHAGIC SHOCK AND SUBSEQUENT WHOLE-BODY IRRADIATION. Sakurai, Kenji (Jikei Univ., Tokyo). Tokyo Jikeikai Ika Daigaku Zasshi; 85: No. 3, 299-313(May 1970). (In Japanese).

Suppression or blocking of the reticuloendothelial and pituitary-adrenocortical systems is shown to lower the tolerance against subsequent stress by increasing susceptibility. The current study was directed and aimed to clarify duration and extent of this increased susceptibility, induced by the sublethal hemorrhagic shock, to subsequent stress, namely to whole-body irradiation. Female Swiss Albino mice were subjected to hemorrhage. Critical bleeding volume was determined from a dose-response curve and Berkson's Logit method. Similarly, length of survival and mortality rates of the mice at various doses of whole-body irradiation were calculated. Then the mice were exposed to sublethal hemorrhagic shock (3.1% body weight) followed by supralethal (1000 R) or sublethal (400 R) irradiation in different intervals, 3 hrs, 24 hrs, and 8 days. The mortalities and the length of survivals were analyzed. Only the group of mice subjected to the 1000 R irradiation 3 hrs following the shock succumbed earlier than the control. The results indicated that the shocked mice were susceptible to the subsequent irradiation only if the adverse effects of irradiation took place early enough to be added to the changes ellicited by the sublethal shock. However, recovery from the shock was prompt. In general, by the time when the irradiation changes took place, the animals recovered from any adverse effects of the shock. There was no such mutual enhancement or potentiation by two sublethal stressors observed in mortalities. At any rate, the effects of the sublethal hemorrhagic shock influencing susceptibility to the subsequent stress appeared to be short lived. Probable roles of the RES and the pituitary-adrenocortical systems during exposure to the stresses were speculated. (auth)

58110 RADIATION PROTECTION STUDIES IN ADULT, WEANLING, AND NEONATAL MICE. Rauchwerger, Joel M. Philadelphia; Temple Univ. (1971). 103p. University Microfilms Order No. 71-19,964.

Thesis.

It has been suggested that the radiosensitivity to acute whole-body X-irradiation (LD/50 for 30 days) varies with age in mice, adults and neonates being relatively radioresistant compared to weanlings. Furthermore, it has been shown that the capacity to be protected against hemopoietic death decreases as the age of the mouse decreases from adult to weanling. Thus, it was of interest to determine whether the capacity of the neonate to be protected against hemopoietic death varies with the radiosensitivity, or directly with the age of the mouse. Survival data are presented for both unshielded and tibial shielded C3H/C57bl mice. Results show that neonates can be protected as well as adults i.e., in both the protective factor or "dose reduction factor" (DRF) was approximately 1.7. However weanlings, which have the highest absolute radiosensitivity, cannot be protected as well (i.e., DRF approximately 1.4). Since the basic cause of death following irradiation in the LD/50 range is known to be due to hemopoietic failure, and since all age groups were protected against hemopoietic death to variable extents, the survival data were correlated with the hematological findings in all three age groups for: (a) irradiated-no shield, (b) irradiated-tibial shield, and (c) non-irradiated controls. The hematological studies included: (a) peripheral blood counts (red blood cell, reticulocyte, white blood cell, platelet, and hematocrit), (b) bone marrow cellularity (nucleated cell count) and (c) spleen evaluation, (splenic weight, and histologic sections). Regardless of the age group, a striking similarity was observed in the hemopoietic response following radiation exposures of equivalent lethality. Unshielded mice of all ages died from what is commonly termed hemopoietic death. However, evidence indicates that the hemopoietic systems in different age groups might have differing radiosensitivities, since at different absolute exposures (although equivalent lethalities), there was a similarity of response in both decline and recovery of hemopoietic parameters in shielded mice. On this basis the hemopoietic system of weanlings is the most radiosensitive since they received the lowest exposure. The basis for the poor weanling protectability was found to be correlated with an increased radiosensitivity of the gastrointestinal system. Weanlings exhibited 3 to 6 day "gut death" at X-ray exposures that were closer to their hematopoietic LD/50 than either adults or neonates. (Diss. Abstr.)

58111 REGENERATION OF INTESTINAL MUCOSA AFTER IRRADIATION. Withers, H. R. (Univ. of Texas, Houston). Cancer; 28: No. 1, 75-81(Jul 1971).

From first national conference on cancer of the colon and rectum; San Diego, Calif. (7 Jan 1971). See CONF-710115.

Data are presented on the time-course of regeneration of proliferative (clonogenic) cells of the intestinal mucosa of mice following radiation injury. The changes in the cell loss pattern were correlated with the histologic appearance of the irradiated intestine. In the investigations of jejunal response, a dose of 660 rads of x rays was delivered to the whole abdomen. This reduced cellular survival in the crypts to about 5% of normal. In the experiments on colonic mucosa, the dose of γ rays was 700 rads, which is roughly equivalent to 600 rads of x rays. (auth)

58112 PATHOLOGIC CHANGES IN THE ULTRASTRUCTURE OF HEPATOCYTES IN THE AXOLOTL (AMBYSTOMA TIGRINUM GREEN) UNDER THE INFLUENCE OF ROENTGEN RAYS. Turska, Ryszarda (School of Agriculture, Wroclaw). Acta Med. Pol.; 12: No. 2, 231-3(1971).

From fourth conference of electron microscopy; Lublin, Poland (26 Nov 1969). See CONF-691138.

Adult salamanders (Ambystoma tigrinum) were exposed to a single dose of 1200 R x radiation and killed one hour later. Changes in the ultrastructure of liver cells induced by irradiation are described. (C.H.)

58113 INFLUENCE OF UV RADIATION ON SOME PHYSICO-CHEMICAL PROPERTIES, BIOCHEMICAL PARAMETERS, AND SUBMICROSCOPIC STRUCTURE OF PIGEON ERYTHROCYTES IN VITRO. Andrzej, Ignacy; Klynczak, Joanna Alina; Sysa, Andrzej; Kwiatkowski, Bartlomiej; Sysa, Jozef (Military Medical Academy, Lodz, Poland). Acta Med. Pol.; 12: No. 2, 292-7 (1971).

From fourth conference of electron microscopy; Lublin, Poland (26 Nov 1969). See CONF-691138.

Pigeon blood in vitro was exposed to uv radiation with emission of 4.33×10^8 erg/sec for periods of 5 hours. The following examinations were made: determination of sensitivity/resistance of erythrocytes in hypotonic NaCl solutions; degree of reversion of hemolysis; changes in erythrocytic volume; content of Na$^+$ and K$^+$ in the plasma, blood, and erythrocytes; levels of some of the phosphate esters (ADP, ATP, and AXP) involved in energetic exchange in cells; and acetylcholinesterase activity in erythrocytes. The fine structure of the erythrocytes and chromium-shadowed erythrocytic membranes were studied electron-microscopically. (auth)

58114 ELECTRON MICROSCOPIC STUDY ON ACUTE THYMIC INVOLUTION INDUCED BY POLYOMA VIRUS INFECTION. **Imamura, Masakatsu; Matsuyama, Tsutomu; Toh, Kentaro; Okuyama, Tomizo (Sapporo Medical Coll.). J. Nat. Cancer Inst.; 47: No. 2, 289-99(Aug 1971).**

Acute thymic involution induced by polyoma virus (PV) in AKR mice was studied ultrastructurally. The involuted thymuses were characterized by the presence of abundant nuclear debris derived from thymic lymphocytes (TL). Besides intercellular spaces, TL were included within the cytoplasm of epithelial reticular cells and macrophages. In epithelial cell cytoplasm, TL often contacted the nuclear membrane, and occasionally the limiting membrane, which surrounded these TL, was obscured. PV particles were often detected in epithelial cell nuclei and in phagosomes of macrophages. Their presence in epithelial cell nuclei and the consequent development of epithelial thymoma in adults strongly suggest that epithelial cells in the thymus are susceptible to PV and are transformed just after PV infection at the neonatal period. Their roles in lymphogenesis during early life and in regulation of peripheral lymphocytes suggest that TL destruction is caused by the functional alteration of the epithelial reticular cells. PV particles were not found in most of the destroyed TL, and direct viral participation in TL destruction was not evident. Peculiar osmiophilic dense structures occasionally observed near the altered TL nuclei were studied morphologically and compared with structures detected in thymuses involuted by cortisone or x irradiation. (auth)

58115 ROLE OF BONE MARROW OF X-IRRADIATED MICE IN THYMIC RECOVERY. **Blomgren, Henric (Karolinska Institutet, Stockholm). Cell Tissue Kinet.; 4: No. 5, 443-61(Sep 1971).**

The influence of the bone marrow on the repopulation of the thymus in x-irradiated mice has been investigated. It was observed that the thymus and a certain population of bone marrow lymphocytic cells were repopulated in parallel in a cyclic fashion. This occurred either after a single exposure of mice to 400 R or after serial weekly x-ray treatments with 170 R. Lethally irradiated recipients which were grafted with bone marrow cells obtained 12–24 days after four weekly irradiations of donor mice with 170 R also exhibited a cyclic repopulation of both the thymus and the bone marrow lymphocytic population. In contrast, mice which were transplanted with bone marrow cells from unirradiated donors, containing an equal number of stem cells (CFU), exhibited a continuous rather than a cyclic recovery of both cell populations. The bone marrow stem cells of mice recovering from x-irradiation were found to have a decreased proliferative activity, since they produced significantly smaller spleen colonies in lethally irradiated recipients than marrow cells from unirradiated mice. The results were interpreted as indicating that the bone marrow lymphocytic cells may act as thymic precursor cells and that thymic lymphopoiesis is dependent on the presence of such cells. Evidently, the production of lymphocytic cells will decrease when the stimulus for granulocyte production increases due to the limited proliferative activity of the surviving bone marrow stem cells after irradiation. This may result in a cyclic variation of the production of bone marrow lymphocytic cells and it follows that thymic lymphopoiesis will run parallel. (auth)

58116 EFFECT OF X-IRRADIATION ON MITOTIC ACTIVITY OF BONE MARROW CELLS OF LABORATORY AND WILD RATS. **Badr, F. M.; Badr, Ragaa S. (National Research Centre, Cairo). Folia Biol. (Prague); 17: No. 4, 258-63(1971).**

Changes in mitotic activity of bone marrow cells of wild (Rattus rattus) and laboratory (Rattus norvegicus) rats irradiated with x-ray doses of 400, 600, 800 and 1,000 R were followed 4 hours, 24 hours and then weekly till the fourth week after the treatment. Significant differences were found between the two strains of rats. Before irradiation, the mitotic index was higher in wild rats, but their lower radiation resistance resulted in a significantly greater depression of mitotic activity after 400 and 600 R. In accord with that, recovery from radiation-induced mitotic inhibition was evident earlier in laboratory rats, starting already in the third postirradiation week. (auth)

58117 MORPHOLOGICAL CHANGES IN THE SPLEEN OF IRRADIATED MICE NINE DAYS AFTER THE TRANSPLANTATION OF HOMOLOGOUS BONE MARROW. **Viktora, L. (Inst. of Haematology and Blood Transfusion, Prague). Folia Morphol.; 19: No. 2, 182-6(1971).**

The state of haematopoiesis in the spleen and the participation of the individual blood components was studied in lethally irradiated mice nine days after the transplantation of preserved fresh homologous bone marrow. It was found that erythropoiesis played the major part, and that granulocytopoiesis also participated significantly, in the regeneration of haematopoiesis in this phase. (auth)

58118 ELECTRON MICROSCOPIC OBSERVATIONS OF RAT MEDULLARY RETICULAR TISSUE AFTER SHORT-TERM, WHOLE BODY GAMMA IRRADIATION. **Dodson, Ronald F. (Baylor Coll., Houston, Tex.). Acta Neuropathol.; 17: 353-62 (1971).**

The ultrastructural observations recorded after shortterm, whole body gamma irradiation on medullary reticular tissue were evaluated. Twenty-five adult rats were divided into one control and four irradiated groups which received 1,000 rads, 2,000 rads, 5,000 rads, and 10,000 rads, respectively. Tissue preparations in each group consisted of immersion fixation in veronal acetate buffered OsO_4 and a perfusion technique utilizing s-collidine buffered glutaraldehyde. The micrographs from the control group revealed conformity to neurological ultrastructures as reported by other authors, with one exception. A structure termed "concentric membranous body" (CMB) was observed in the s-collidine buffered, perfused animals. This structure was noted to be associated with neuronal membranes and to contain laminated repeating intraperiodicity of 40 to 50 Å. In all irradiated groups (1,000, 2,000, 5,000, 10,000 rads) membranous swirls were observed. These structures appeared to be of CMB origin in the lower exposure groups and from both CMB and myelin sheath breakdown in the higher groups. Progressive cytoplasmic vacuolization, mitochondrial, and myelin sheath damage were noted as being related to dose level. Since no apparent capillary bed damage was observed in any irradiated animal, it was concluded that the cellular abnormalities recorded were the result of direct or localized irradiation damage of the brain. (auth)

58119 VARIATIONS IN THE RELATIONSHIPS BETWEEN TOTAL ^{59}Fe UPTAKE AND THE UPTAKES INTO HEME AND NONHEME FRACTIONS OF SPLEEN AND BONE MARROW IN IRRADIATED MICE AND MOUSE RADIATION CHIMERAS. **Gresham, P. A.; Barnett, M.; Goksoy, K.; Smith, S. Vaughan (Univ. of Birmingham, Eng.). Blood; 38: No. 3, 343-52(Sep 1971).**

A chemical method for the separation of heme and nonheme iron-containing fractions in mouse tissues has been used to study the uptake of ^{59}Fe into both the heme and nonheme iron fractions in spleen and femoral bone marrow, in order to investigate the possible relationships between the total uptake into spleen tissue and the rate of uptake into the heme fractions. In control mice, only about one third of the ^{59}Fe is directly associated with heme during the first day after administration, and this fraction decreases as radioactive red cells are released from the spleen into blood. Ten days after x-irradiation of mice, the proportion of ^{59}Fe in the spleen heme fraction 6 hr after intraperitoneal administration decreased about 30 to 10% of the total splenic activity as the radiation dose was increased from 500 to 750 rads. A similar alteration in the proportion of ^{59}Fe in the spleen haem fraction occurred in mouse radiation chimeras as the dose of injected syngeneic bone-marrow cells was reduced from 5×10^5 to zero. Similar results were found in femoral bone marrow. These results indicate that in this system the rate of uptake into whole tissue is not a measure of the uptake into heme; it is necessary, therefore, to use the method involving the measurement of iron uptake into heme, rather than the total tissue uptake, when estimating hemoglobin synthesis or erythropoiesis. (auth)

58120 CHARACTERIZATION OF SMALL SIZE LYMPHOID CELLS IN IRRADIATED AND NORMAL MOUSE BONE MARROW. **Haot, J.; Haughton, G.; Revesz, L. (Karolinska Institutet Medical School., Stockholm). Exp. Cell Research; 66: 171-6(May 1971).**

Suspensions of bone marrow cells from irradiated and unirradiated mice were labelled with ^{51}Cr-sodium chromate or ^{59}Fe-citrate. Due to a specific release of the incorporated isotopes by treatment of the cells with H-2 isoantisera, on the average 25% of ^{51}Cr and 8% ^{59}Fe was liberated. Cells which survived antiserum treatment were able to incorporate ^{59}Fe at a normal rate. The results were related to the effect of the antisera on the volume distribution of the bone marrow cell population. In conjunction with previous cytologic studies, it was concluded that the cell population destroyed by antiserum treatment belongs to the lymphoid series. Erythroid cells, if destroyed at all, constitute only a minor component of the killed population. Lymphoid cells in the regenerating bone marrow of irradiated animals appeared to be as sensitive to antisera as the lymphoid cells of normal bone marrow. (auth)

58121 OSTEOGENIC PRECURSOR CELLS OF BONE MARROW IN RADIATION CHIMERAS. **Friedenstein, Alexander; Kuralesova, Albina I. (Inst. for Epidemiology and Microbiology, Moscow). Transplantation; 12: No. 2, 99-108(Aug 1971).**

A study of the osteogenic and hematopoietic capacities of bone marrow precursor cells was made by transplanting allogeneic marrow and semisyngeneic parental marrow under the renal capsules of F_1 hybrid mice. The results indicate that the osteogenic precursor cells (OPC) of semisyngeneic marrow remain active for protracted periods without replenishment by hematopoietic cells. The independence of OPC from hematopoietic cells is confirmed by transplants to lethally irradiated hybrids, since the OPC are capable of self-maintenance in this situation without the possibility of stem cells being provided by the recipient. It is concluded that marrow contains independent lines of OPC and hematopoietic stem cells. Allogeneic marrow is subject to immunological rejection, as is syngeneic male marrow transplanted to presensitized females. (auth)

58122 CARDIOVASCULAR CHANGES IN EXPERIMENTAL RADIATION DISEASE. STUDY OF THE LITERATURE OF THE PERIOD 1965–1969. Kuna, P. Cas. Lek. Cesk.; 110: No. 21, 486-91(1971). (In Czech).

The whole-body irradiation of laboratory animals causes marked cardiovascular changes. Literature data from the last 5 years point out the prevailing hypotension with changes in vascular permeability and heart action. In the histologic preparations most frequently are encountered haemorrhages, degenerative changes of the myofibrils and subsequent fibrosis. There is a decrease in oxygen consumption, quantity of macroergic phosphates and in the nucleic acids. Furthermore potassium leakage, sodium accumulation and change in the activity of a number of enzymes take place. The results obtained by individual authors frequently are contradictory. Of interest is the favorable effect of radioprotective agents on some postirradiation changes in the myocardium. (auth)

58123 EFFECT OF BONE MARROW HOMOTRANSPLANTATION ON ^{32}P INCORPORATION INTO CELLULAR PROTEIN OF THE LIVER, SPLEEN, AND BONE MARROW IN ACUTE RADIATION SICKNESS. Shamrai, A. E. Vrach. Delo; No. 5, 127-9 (1971). (In Russian).

Rats were x-irradiated and bone marrow was transplanted intravenously 24 hr later. Thirty min later the animals were injected with ^{32}P. A marked increase in ^{32}P incorporation was observed on the fourth day followed by a decrease up to the thirteenth day. The decrease was prevented by homotransplantation. Animals not receiving transplants died by the thirteenth day. The temporary decrease in ^{32}P incorporation noted on the third day is apparently associated with suppression of protein synthesis by the presence of foreign proteins in the recipient. It is suggested that normalization of protein synthesis is one of the favorable influences of bone marrow transplantation in irradiated recipients. (H.L.W.)

58124 EFFECT OF PARTIAL MARROW SHIELDING ON HEMATOPOIETIC RECOVERY IN HEAVILY IRRADIATED MICE. Ito, Takaaki; Ito, Akihiro; Imamura, Nobutaka; Kawase, Akira; Yamasaki, Takao (Hiroshima Univ.). Hiroshima Daigaku Genbaku Hoshano Igaku Kenkyusho Nenpo; No. 10, 61-74(May 1969). (In Japanese).

The present experiments were undertaken to assess the effect of partial body shielding on the recovery of the hematopoiesis and lymphopoiesis in lethally irradiated animals. The hematopathological and autoradiographic assays for spleen colony formation were applied to heavily x-irradiated mice in which either the shielded limb was amputated at various intervals after x-irradiation or the various doses of sublethal x-irradiation were given to a shielded limb. The hematopoietic recovery was markedly promoted by the shielding of one hind limb. This effect seemed to be attributable to the repopulation of hematopoietic cells in irradiated sites, which is generated by the hematopoietic stem cells (HSC) from the shielded marrow. The number of HSC in the shielded marrow showed no significant decrease during the first 5 hours after x-irradiation though certain numbers of HSC appeared to migrate to the irradiated sites during this period. The migrating HSC appeared to possess affinity to certain specific sites according to their potential cell type: erythroid cells to the spleen and granuloid cells to the bone marrow. Megakaryocytes were distributed approximately equally in both spleen and marrow. The decrease of migrating ability or mitotic inhibition of HSC would be brought about by a relatively small dose (200 R), leading to the retardation of the hematopoietic recovery of the irradiated sites as compared to mice, a part of whose hematopoietic sites has been completely shielded during irradiation. The partial shielding of hematopoietic sites gave also a beneficial effect to the recovery of the lymphoid tissues. In this process, the regeneration of the peripheral lymphoid tissues such as white pulp of the spleen or lymph nodes was preceded by that of thymus. (auth)

58125 STUDIES ON LOCAL CIRCULATION IN X IRRADIATED SKIN BY USING ^{131}I. Kanasaki, Yoshiki (Osaka Medical Coll., Takatsuki, Japan). Osaka Ika Daigaku Zasshi; 28: No. 3-4, 256-71(Dec 1969). (In Japanese).

Patients undergoing x-ray treatment of the subcutaneous tissues were injected subcutaneously with ^{131}I for studies on dermal circulation. The disappearance rate of ^{131}I in the skin was obtained from the half time by measuring and recording changes in radioactivity. The disappearance rate in the femoral skin of x-irradiated rabbits was compared with that of human subjects. Disappearance rates increased in x-irradiated skin and the rate was higher in the dorsal than in the abdominal area. Effects of age on disappearance were also studied. (Japan)

58126 BIOCHEMICAL INDICATORS OF RADIATION INJURY: PRESENT STATUS AND PROSPECTS. Gerber, G. B. (EURATOM, Brussels. SCK/CEN, Mol, Belgium). pp 705-17 of Advances in Physical and Biological Radiation Detectors. Vienna; International Atomic Energy Agency (1971).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970). See STI/PUB-269; CONF-701112.

Use of biochemical indicators represents an attempt to assess radiation injury on the basis of metabolic changes in the irradiated organisms. Early effects of radiation may be classified as cellular effects (interphase death, delayed transit through the cell cycle, and reproductive failure) and systemic effects. Among these changes, interphase death and systemic effects are best accessible to biochemical tests, but are perhaps less important for the survival of the organism than is reproductive failure of cells. Nevertheless, biochemical indicators respond early and measurements are easy to execute; they may therefore be of value for an early assessment of the extent of radiation injury despite their low specificity. Examples of various types of biochemical indicators in the irradiated body are presented and the metabolic mechanisms involved in these changes are discussed. (auth)

58127 CLEFT PALATE AND/OR OLIGODACTYLIA IN THE MOUSE EMBRYO INDUCED ON DIFFERENT DAYS OF PREGNANCY BY VARIOUS DOSES OF X RAYS OR CYCLOPHOSPHAMIDE. Gebhardt, D. O. (National Inst. of Public Health, Utrecht). Acta Morphol. Neer.-Scand.; 8: 240-1(Feb 1971).

Pregnant mice were x-irradiated with different doses and treated with cyclophosphamide at various stages of development. The largest frequency of malformations was obtained when the mice were irradiated on the twelfth day. At term all fetuses had a reduced number of digits of the forelimbs and 96% had a cleft palate. It was concluded that: the optimal stage for the induction of a malformation depends on the nature of the teratogenic agent; the induction of cleft palate by x rays is a process which is independent of the induction of oligodactylia; and the changes in development caused by administering a teratogenic agent on various dose levels can best be studied using a three dimensional model with a time, dose, and effect axis. (H.L.W.)

58128 MORPHOLOGICAL STUDY OF ORGANS, BLOOD CELLS, AND BONE MARROW OF WHITE RATS AND MICE WITH VACCINAL DISEASE. Svet-Moldavskaya, I. A.; Yumasheva, M. A.; Shershukova, E. M.; Ravkina, L. I.; Osipova, T. V. (Research Inst. of Viral Preparations, Moscow). Acta Virol. (Prague) Engl. Ed.; 14: No. 3, 257-60(1970).

Histological examination revealed inflammation foci, mainly in the lungs, in animals in which the terminal stage of vaccinal disease developed. Similar lesions were observed in the lungs of irradiated but uninfected animals and in non-irradiated animals inoculated with the same dose of virus. The changes in the bone marrow and blood cells were similar to those observed in animals after irradiation, regardless of virus administration. A possible mechanism of the development of vaccinal disease is discussed. (NSA of Czech)

58129 NEUROSECRETION CELLS OF THE DOG HYPOTHALAMUS DURING ACUTE RADIATION SICKNESS. Pishchinskii, A. V.; Chevlytko, A. A. (Minsk Medical Inst.). Dokl. Akad. Nauk BSSR; 15: No. 3, 277-9(Mar 1971). (In Russian).

A study was made of the neurosecretory cells of the hypothalamus of 13 dogs in the terminal stages of radiation sickness. The latter was caused by whole-body irradiation of 600 R. It was observed that whole-body irradiation brings about not only a disturbance in the neurosecretory process (cell destruction, a setback in cell secretion), but also significant destructive changes in the secreting cells (shrivelling, vacuolization of the cytoplasm). (tr-auth)

58130 REPAIR OF RADIOLESIONS RESPONSIBLE FOR THE FORMATION OF MICRONUCLEI AND ANA-TELOPHASE BRIDGES IN THE RAT LIVER. Barbason, H. (Univ., Liege). Arch. Biol. (Liege); 81: 51-60(1970). (In French).

Whole-body irradiation of rats with 450 R x radiation produced nuclear lesions in liver cells. These lesions manifest themselves histologically during regeneration following partial liver resection. When the resection was performed immediately after radiation, the mitotic index was partially inhibited and the mitoses were associated with the important production of micronuclei and anatelophase bridges. Evolution of these mitotic anomalies was studied by separating liver resection and irradiation through different time spans. During the first six weeks of such delay, restoration of mitotic activity coincided with diminution of micronuclei and augmentation of bridges. When the delay reached up to 15 weeks, the number of micronuclei remained practically stable, whereas bridges diminished significantly. The differences between origin of micronuclei and origin of the bridges were analyzed and a hypothesis proposed. (H.B.G.)

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Refer also to abstracts 57937, 57938, 57963, 58000, 58011, 58013, and 58077.

58131 (CEA-CONF-1768) STUDY OF CELLULAR ULTRASTRUCTURE AND MITOTIC INDEX IN VITRO OF LYMPHOCYTES OF CHRONIC LYMPHOID LEUKEMIA DURING TREATMENT OF THE BLOOD BY EXTRACORPOREAL IRRADIATION. Marcille, Melle G.; Sotto, M. F.; Schaerer, R.; Suscillon, M.; Patet, J.; Hollard, D. [nd]. 16p. (In French). (CONF-700820-2). Dep. NTIS (U. S. Sales Only).

From thirteenth international congress of hematology; Munich, Germany (24 Aug 1970).

Two techniques were used to discover whether the extracorporeal irradiation of the blood of chronic lymphocytic leukemia either reduced the number of lymphocytes, or contributed to the disappearance of these cells and their replacement by normal lymphocytes: the circulating lymphocytes were observed with an electron microscope; the mitotic index was measured in a lymphocytic culture in the presence of phytohemagglutinin. Morphological details observed by means of electron microscopy of the lymphocytes are described and illustrated. (France)

58132 STUDY OF IMMEDIATE RETRANSPLANTATION OF X-IRRADIATED MANDIBLE AFTER MANDIBULAR RESECTION. I. CLINICAL RESEARCH. Sato, Kimihiko (Kyushu Dental Coll., Kitakyushu, Japan). Kyushu Shika Gakkai Zasshi; 24: No. 2, 141-59(Jul 1970). (In Japanese).

The immediate retransplantation of mandibular pieces, from which visible lesions were removed, was performed following a single 5000 R x-ray exposure. The cases consisted of a cancer group (4 cancers) and a non-cancer group (a mixed epidermoid and follicular cyst, mycosis, osteoma, and ameloblastoma). Particular differences between the cancer group and the non-cancer group were revealed by clinical and roentgenological studies from 6 months to 34 months after the operation. In the cancer group, 5 months postoperative x-ray films showed that pseudoarticulation formed at the conjunctive portions of the retransplanted mandible and the host. However, the retransplanted ascending ramus functioned well in its role. New bone formation surrounding the grafts or enlargement of the transplanted bone itself, which was observed in cases of fresh autogenous graft, could not be seen. The effects of pre- and postoperative x irradiation on the surrounding soft tissues were greater than that of the 5000 R single irradiation on the retransplanted mandibular pieces. In the non-cancer group, callous production began at the contact portion of the remaining mandible and the retransplanted mandibular pieces by 2 or 3 weeks after the operation. Further, resorption and smoothing of sharp edges of the transplanted mandible were observed. The functional reconstruction of the transplanted mandible continued day after day resulting in mandibular arch recovery. Moreover, new bone formation was observed at the alveolar edges or the portion of the process coronoideus and it connected partly to the retransplanted mandible. However, the enlargement of transplanted bone observed in fresh autogenous bone grafts could not be seen in the present grafts and the speed of functional reconstruction was slower in comparison with fresh autogenous bone graft. No recurrent tumor from retransplanted mandibular pieces was observed during this period. (auth)

58133 HETEROTOPIC BONE FORMATION IN THE LUNG. Kamada, Toru; Hara, Hiroshi (Hiroshima Univ.). Hiroshima J. Med. Sci.; 19: No. 1, 11-21(Mar 1970).

Three cases of heterotopic bone formation of the lung unassociated with tuberculous scars have been reported. Two of them are cases of multiple myeloma. The lung is characterized by formation of discrete small nodules of bone sparsely distributed in the alveolar spaces throughout the organ. Bone formation in the lungs of rabbits caused by repeated x-ray irradiation and administration of adrenocortical hormones was described. The picture of bone formation in rabbits was remarkably similar to that seen in the autopsy cases. The pathogenesis of heterotopic bone formation in the lungs was discussed. (auth)

58134 EXAMINATION OF BLOOD COUNTS ON THE RADIOLOGICAL TECHNICIANS IN JAPAN. Endo, Kouichi; Ishizaka, Masatsuna (Inst. of Public Health, Tokyo). Nippon Hoshasen Gijutsu Gakkai Zasshi; 26: No. 5, 1-8(Mar 1971). (In Japanese).

A survey was conducted of radiation hazards to clinical radiation technicians working in health centers, national hospitals, national sanitoriums and some general hospitals during 1969. Based on the observation that disturbances in the hemopoietic system are the most pronounced symptoms of radiation hazard, data on blood counts in these workers was statistically evaluated as follows. The average blood count and standard deviation of these blood counts in all radiation technologists in the institutions mentioned above were as follows: WBC 6,298 ± 1,359/mm^3 (1,428 persons), RBC 468 ± 48 × 10^4/mm^3 (1,413 persons), and Hb 93.7 ± 9.1% (1,326 persons). Several blood tests are conducted every year on radiological technicians. The yearly fluctuation of cell counts for WBC was less than 5,000/mm^3 in 36.3% and for RBC less than 450 × 10^4/mm^3 in 66.9%. Classification of blood cell counts into normal and abnormal values revealed abnormal values for either RBC or WBC in about one-half of the cases. In 131 persons, abnormal values for both were noted. In persons with a history of radiation hazard in the past, the WBC was significantly lower than in those technicians without radiation hazard. (auth)

58135 VESICOVAGINAL FISTULA, RADIATION, AND GYNECOLOGIC CANCER. Boronow, Richard C.; Rutledge, Felix (Anderson Hospital and Tumor Inst., Houston, Tex.). Amer. J. Obstet. Gynecol.; 111: No. 1, 85-90(1 Sep 1971).

Radiation and combined radiation and surgical procedures were common denominators in 73 vesicovaginal fistulas reviewed. Only 1.2% of 2,729 patients with cervical cancer treated by radiation therapy developed vesicovaginal fistula. The rate was definitely higher in the small number of cases that had combined radiation and hysterectomy. These data show little difference in the rate of fistula formation when correlated with clinical stage of a cervical cancer. The major management experience involved colpocleisis (either complete or partial) and urinary diversion (primarily by ileal conduit but also by sigmoid conduit). Colpocleisis seems most suitable for patients with normal intravenous pyelograms, size and location of fistula permitting partial rather than complete colpocleisis, and a patient who will accept compromise of vaginal depth. Conduit urinary diversion is excellent for the fistula that cannot be closed vaginally. Other techniques, however, for vaginal fistula closure should be explored prior to selecting urinary diversion as the definitive method of management. (auth)

58136 EFFECTS OF IN VITRO ^{60}Co γ IRRADIATION ON ^{51}Cr-LABELED RED BLOOD CELLS. Ishikawa, Daizi; Yasukochi, Hiroshi (Tokyo Univ.). Nippon Igaku Hoshasen Gakkai Zasshi; 29: No. 12, 1501-6(Mar 1970). (In Japanese).

Gamma-irradiated ^{51}Cr-labeled red blood cells were administered to the patient for scanning of the spleen. By this method, the reproducibility of the degree of destruction of red blood cells was superior than that of the heat treating method and better scintigrams are obtained. An investigation was performed on the degree of destruction of the red blood cells by γ irradiation. Extensive destruction of the red blood cells started at doses of about 300,000 R and 25% of the red blood cells were destroyed at 400,000 R. The best scintigrams were obtained using the red blood cells irradiated at doses between 300,000 and 340,000 R. Several comparisons were made between γ-treated and heat-treated red blood cells. Red blood cell aging induced by γ irradiation was suggested by the daily destruction of cells stored in a freezer after 350,000 R irradiation. The degree of destruction of red blood cells was 50% at one day after irradiation and 90% after two days. The determination of the cell aging must be made by cell survival determinations in the patient (in vivo), but this in vivo decay suggests the shortening of the cell survival determination method if a correlation between the irradiation dose in vitro and cell survival in vivo is obtained. The aging of red blood cells by ^{60}Co γ irradiation is discussed in comparison with that of the heat treating method and some clinical applications are suggested for spleen scintigram procedures and red cell survival determinations. (auth)

58137 RADIOTHERAPY OF LUNG CANCER. Yamada, Masahiro; Nagase, Tetsuya (Keio Univ., Tokyo). Rinsho Kagaku; 6: No. 4, 475-80(Apr 1970). (In Japanese).

A broad review of radiotherapy of lung cancer, mainly from published literature, is presented. In principle, irradiation is made by a two-field method, the standard dose being 5000 to 6000 rads for undifferentiated carcinomas, 6000 to 7000 rads for squamous cell carcinomas, and above 7000 rads for adenocarcinomas. Diminution by irradiation, as judged from tumor shadow, is 17% for sieve x radiation, 23% for high-dose ^{60}Co irradiation, and 28% for super-high voltage x irradiation. The unchanged rates are 45%, 25%, and 10%, respectively, showing the effectiveness of super-high voltage x irradiation. The tumors liable to undergo diminution are undifferentiated carcinomas with strong sensitivity followed by squamous cell carcinomas and adenocarcinomas. However, the therapeutic rate is poor in undifferentiated carcinomas and good in squamous cell carcinomas. One-yr survival rates are 20% for sieve x irradiation, 30% for large-dose ^{60}Co, and 40% for super-high voltage x-ray therapy, still showing the good effect of the last therapy. The difference between these decreased to 11, 15, and 20% for 2-yr survival and no great difference was seen for 3-yr survivals due largely to the frequency of deaths due to metastasis 2 to 3 yrs after radiotherapy. Surgery and chemotherapy are being used to raise this survival rate but current results are not good. Radiotherapy often results in radiation pneumonia corresponding to the site of irradiation, often progressing to fibrosis of the lung or resulting in myocardial damage when irradiation is over a wide field. Radiation myelitis is often seen in aged patients. (Japan)

58138 RADIATION EXPOSURE IN AIR TRAVEL. Schaefer, Hermann J. (Naval Aerospace Medical Research Lab., Pensacola, Fla.). Science;/173: No. 3999, 780-3(27 Aug 1971).

The prospect of present-day, large-scale passenger operations shifting from jet aircraft to supersonic transports (SST), flying at two to three times the speed of sound and at altitudes of 60,000 to 65,000 feet, has raised the question of what harmful effects the substantially higher levels of environmental radiation could have on crew members and passengers. An evaluation and comparison of the environmental radiation levels at conventional jet and at SST altitudes is presented. It is concluded that levels of ionizing radiation at the high altitudes encountered during supersonic transport will not significantly increase the population dose. (C.H.)

58139 IRRADIATION HAZARD IN MEDICINE. A PRESSING PROBLEM. Fridrich, R. (Univ., Basel). Praxis (Bern); 60: 5-12(5 Jan 1971). (In German).

Somatic and genetic radiation effects on man are reviewed. In highly industrialized countries, natural background radiation amounts to about 120 mrad/year, whereas exposure through industry and medicine contributes 30 to 40 mrad/year/person. A comparison was made of the radiation burden between x radiation and radioisotope diagnostic procedures. It was concluded that neither industrial nor medical application of radiation represents a noticeable risk to mankind. Nonetheless, only those physicians with special training should use radiation equipment. (H.B.G.)

58140 IRRADIATION CHANGES IN NORMAL AND ATYPICAL SQUAMOUS EPITHELIUM OF THE CERVIX UTERI. Hilgarth, M. Med. Lab.; 23: 185-8(Aug 1970). (In German).

With respect to local recurrence of cervical tumors, the cervix epithelium in 40 patients was studied cytologically and histologically following radium, roentgen, and telecobalt therapy. In 29 patients, agreement existed between cytological and histological findings. Eleven patients showed disagreement, whereby the cytological results proved falsely negative in 10 and falsely positive in one. It was concluded that cytological tests were valuable for detecting local recurrence of tumors; however, because of their technical and morphological difficulty, they should only be performed with the necessary reservation by experienced investigators. (H.B.G.)

58141 INFLUENCE OF BODY INHOMOGENEITIES ON DOSE DISTRIBUTION DURING ELECTRON AND ROENTGEN IRRADIATION WITH A 42 MeV BETATRON. Fehrentz, D.; Franz, K.-D. (Univ., Heidelberg). Therapiewoche; 21: No. 19, 1551-2; 1554; 1557-9(12 May 1971). (In German).

The fact that electron therapy only slightly damages tissue behind the target area can be utilized for deep therapy with electrons in excess of 20 MeV. Recommended is application of moving beam radiation to compensate the effects of inhomogeneities on dose distribution, especially dose peaks caused by electron scattering. Under this condition, sufficient protection can be obtained for skin and healthy tissue surrounding the tumor. With ultrahard roentgen rays, up to 45 MeV, bone dose is only insignificantly higher than that to the muscle. X radiation of such high energy proved advantageous in obese patients where target areas must be irradiated at a depth of more than 8 cm. (tr-auth)

58142 MECHANISMS INVOLVED IN THE PHARMACODYNAMIC SENSITIVITY CHANGES IN IRRADIATED ORGANISMS. Voicu, V. Rev. Sanit. Mil.; No. 1, 21-5(Jan-Feb 1970). (In Rumanian).

Ionizing radiations affect the permeability of membranes, enzyme systems, cell morphology, and excretion processes. The central nervous system is considered radiation resistant, up to about 2000 R. Radiation sensitizes the brain, lowers the threshold for the activity of drugs, and inhibits their metabolism by hepatic enzymes. Sensitivity of the organism toward cholinergic substances is affected by changes of cholinesterase after irradiation. The great variety of experimental conditions and doses used for radiation experiments make it difficult to interpret morphofunctional behavior of the heart after exposure. The effect of radiation is revealed by changes in the ECG and by heart rhythm disturbances. The catecholamine concentration in the blood and myocardium is increased both immediately after irradiation and during the peak period of radiation sickness. Radiation reduces the active bound calcium capacity by weakening the bonds, thereby reducing the concentration of cardiotonic agents needed to trigger specific phenomena in the myocardium. These effects must be taken into consideration when developing a therapy for people affected by radiation sickness. (TTT)

58143 EFFECTS OF IRRADIATION ON THE CENTRAL NERVOUS SYSTEM. Tsuya, Asahi (Japanese Foundation for Cancer Research, Tokyo). Gan No Rinsho; 16: No. 6, 658-63 (Jun 1970). (In Japanese).

Fundamental research on the effects of radiation on the central nervous system was carried out over a period of six years by the Ministry of Education. A review of results is presented concerning radiosensitivity, permissible doses, physiological changes, histological changes, clinical findings, and radiation dose necessary to produce cerebral death. Radiation damage to nerve tissue was estimated by direct and indirect methods. Time factors were also examined and results are tabulated. A brief summary of the report of the UNESCO committee on radiation risk is given and plans for future studies are listed. (Japan)

58144 EFFECT OF CHRONIC RADIATION ON THE RESULTS OF THROMBOELASTOGRAPHIC EXAMINATIONS (TEG). Kriklava, J.; Koskova, D. Cas. Lek. Cesk.; 109: No. 33, 761-3(31 Jun 1970). (In Czech).

Thromboelastographic examinations were made in miners of uranium mines exposed to small doses of chronic radiation. Thromboelastographic records were compared with a control group that did not have any contact with ionizing radiation and the results were computed statistically. As to basic TEG values (r, k, ma, mE, and t-ma), there were no significant differences between exposed subjects and controls. There was a significant difference in the firmness of the thrombus but only 90, 120, and 150 min after the onset of coagulation, in the subjects exposed for a prolonged period. There, however, the greater fibrinolytic serum activity is more manifest and is more potentiated. (auth)

58145 DEOXYCYTIDINURIA IN PERSONS OCCUPATIONALLY EXPOSED TO CHRONIC IRRADIATION. Grozdanovic, J.; Vich, Z.; Kratochvil, J.; Truxova, G. Cas. Lek. Cesk.; 109: No. 33, 759-60(31 Jun 1970). (In Czech).

It was revealed that in subjects working in uranium mines, CdR-uria is slightly raised; as compared with a group of workers working on the surface, the difference was, however, not statistically significant. The raised levels of CdR-uria are apparently still within the physiological range. Attention is drawn to the possible effect of the age factor on the level of CdR-uria. (auth)

58146 STUDY OF CELLULAR DIVISIONS IN NORMAL HUMAN EPIDERMIS AND UNDER THE INFLUENCE OF X RAYS. Bogdan, F. Stud. Cercet. Embriol. Citol., Ser. Embriol.; 7: No. 2, 169-74(1970).

The results of an investigation undertaken on normal human tegument from 20 operatory slides for irradiated and non-irradiated mammary neoplasms, histologically processed, stained, and quantitatively microscopically examined are reported. Cellular divisions occur in the local basal stratum (excluding mitoses), and the epidermal spinous stratum (predominantly amitoses and endomitoses in its medium and upper thirds); the irradiating factor induces a lowering of the number of epidermal cellular divisions: 25 days after the last irradiation they are only 50% of the divisions reported in the nonirradiated epidermis. (Rom. Sci. Abstr.)

58147 IRRADIATION SEQUELAE IN THE HEART AND MAJOR VESSELS. Kolar, J. (Karls Univ., Prague). Med. Klin. (Munich); 66: No. 18, 661-8(30 Apr 1971). (In German).

The effects of radiotherapy of thoracic diseases on heart and blood vessels are discussed. Radioinduced pericarditis occurs in some patients. Heart infarcts, however, virtually never occur as a sequela of radiation treatment. Various types of functional disturbances of heart rhythm are observable; they usually are transient and harmless. Radiation can act as a contributing factor in the rupture of heart and vessels during myocardial necrosis. Obliteration of arteries should be considered more seriously as a possible radiation effect. Radioinduced arteriosclerosis remains problematic. Frequency of heart and vessel complications following radiotherapy is so small as to require no change in the normal techniques of radiotherapy. 121 references are given. (H.B.G.)

XUM

Radiation Effects on Plants

Refer also to abstracts 57911, 57927, 57931, 57941, 57960, 57968, 57969, 57974, and 58158.

58148 RADIOSENSITIVITY STUDIES IN SUNFLOWER (HELIANTHUS ANNUS). Rajput, M. A.; Khan, A. H. (Radiation Genetics Inst., Lyallpur, India). Nucleus (Karachi); 8: No. 1-2, 84-7(Jan-Jun 1971).

Air-dried seeds of three varieties, namely, Thatta, Peredovic and HO-1 having 7% moisture content were subjected to 1, 2.5, 5, 7.5 and 10 kR doses of gamma-rays from a 250-curie ^{60}Co source. It has been concluded from these experiments that the variety Peredovic is more susceptible to gamma-rays than the others, and the order of radiosensitivity is Peredovic, Thatta, and HO-1. (auth)

58149 RESISTANCE OF SEEDS OF LUPINE VARIETIES TO X RADIATION. Anokhin, A. S.; Anokhina, V. S. (Minsk Pedagogical Inst.). Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk; No. 3, 56-9(1971). (In Belrussian).

A study of the resistance to 12 kR doses of x-radiation was conducted on narrow-leaf lupine hybrids and original parental forms. Resistance was judged from germination and survival rates. Intervarietal lupine hybrids differed in their degree of resistance to x-radiation within broad limits, from a high degree to total absence of resistance. Those varieties with marked heterosis exhibited a significant degree of radiation resistance, as compared to those lacking heterosis. (tr-auth)

58150 SOME EFFECTS OF IONIZING IRRADIATION ON THE MICROFUNGAL POPULATIONS OF QUERCUS RUBRUM LITTER. Martin, James Weldon. Columbia, S. C.; Univ. of South Carolina (1971). 85p. University Microfilms Order No. 71-21,847.

Thesis.

Microfungal populations inhabiting the litter in a Savannah River Plant forest dominated by Quercus rubrum were studied for 2 months before and 9 months after irradiation by a 9200 curie 137-cesium source. Six experimental sites received from approximately 2500 K R to 4 K R while two control sites received only background radiation. Pre-irradiation studies showed a high degree of similarity between populations in all sites. Immediately after irradiation the three most heavily irradiated sites displayed much lower populations and vastly different species composition than lightly irradiated and control populations. Darkly pigmented fungi withstood irradiation up to 2500 K R and became the dominant species of the immediate post-irradiation populations. However, some lightly pigmented forms were re-established by one month after irradiation and populations of darkly pigmented forms were reduced to near normal. It is suggested that apparent high populations of certain species resulted in the elimination of competition rather than stimulation by ionizing irradiation. Return to normal populations is slow, since abnormalities were still in evidence 9 months after termination of irradiation. The use of irradiation to study functions of certain litter inhabiting species and groups of species by progressive elimination of them is proposed. (Diss. Abstr. Int., B)

58151 SENSITIVITY OF FRUIT AND BERRY PLANTS TO GAMMA RADIATION. Ravkin, A. S. Vestn. Sel'skokhoz. Nauki (Moscow); No. 12, 37-40(Dec 1970). (In Russian).

Critical and sublethal doses of gamma radiation were separately established for seeds, cuttings, rosettes, and entire plants of cultivated berries. Significant differences were indicated in radiation-resistant cultures, and varieties in connection with ploidy, natural variety, and the physiological state at the time of irradiation. Vegetative plants of some cultures are capable of undergoing somewhat higher doses than their seeds and cuttings. (tr-INIS)

58152 RADIOSENSITIVITY OF WHEAT GERM. Chekurov, V. M.; Enken, V. B. (Inst. of Cytology and Genetics, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Biol. Nauk; 3: No. 15, 74-8(Dec 1970). (In Russian).

Four types of wheat were selected for this study of the effect of x-radiation on the gynoecium and determination of the critical dose. With the onset of heading of the wheat the flowers of the maternal plants were castrated, irradiated with 1.5 to 7 kR of x-radiation, then pollinated with freshly gathered pollen of the same variety. Thirty days later the spikelets were cut and examined. Immediate destruction of the female gametes had apparently not resulted from this treatment. Increased dosage of x-radiation to 7 kR lowered caryopsis relative to the control samples by $2^1/_2$ times in soft wheat, and by 4 times in einkorn (Triticum monococcum). Survival rate was inversely proportional to the dose of radiation; the critical dose for the varieties studied was 5 to 7 kR. (K.S.W.)

58153 EFFECTS OF IRRADIATION (HIGH ENERGY β RAYS) ON CLADOPHORALES. I. CHAETOMORPHA MELAGONIUM. Patel, R. J. (Sardar Patel Univ., Vallabh Vidyanagar, India). Nucleus (Calcutta); 13: No. 2, 111-17(Dec 1970).

Five different doses up to 100,000 R of high energy β rays were given to Chaetomorpha melagonium at Hammersmith Hospital, London. Normal quadriflagellate swarmers at lower doses up to 5000 R and masses of non-separated, multiflagellate swarmers at higher doses were studied for the first time in algae. At highest dose, there was a small percentage of surviving swarmers although the plants receiving it died. The effects of irradiation on the chromosomes have been studied in detail. The chromosome aberrations were more frequent as the doses were increased. Effects on meiotic divisions were studied for the first time where 13 bivalents were counted, the normal being 12. Recovery was found up to 53,000 R after two weeks. Only 1 or 2 plants were found from the swarmers at 100,000 R. Cytological picture was normal in these filaments. It may be said that 100,000 R is the lethal dose for Chaetomorpha melagonium Kutz. (auth)

58154 EFFECT OF FERTILIZERS AND SEED IRRADIATION WITH GAMMA RAYS ON THE UPTAKE OF NUTRIENTS IN CORN PLANTS. Mar'ina, V. V. Visn. Sil'skogospodar. Nauki; No. 12, 50-3(Dec 1970). (In Ukrainian).

Experimental investigation showed that the uptake of nitrogen and phosphorus by corn plants in the tasseled stage was increased by irradiation with 1,000 rads of γ radiation. In Kiev-8 hybrid plants, which are more responsive to radiation, essential differences in the uptake of nutritive substances by the irradiated and control plants were noted in the absence of pre-sowing fertilization. In comparison with the controls, the irradiated plants utilized the nutritive substances of the soil and basic fertilizers better; uptake of nitrogen was increased by 9.5 to 32.9%, and phosphorus by 9.4 to 27.7%. The more active uptake in the Kiev-8 hybrid under these conditions was conducive to an increase in grain yield over a three-year average. (tr-INIS)

Radiation Effects on Microorganisms

Refer also to abstracts 57928, 57964, 57965, 57970, 58032, and 58158.

58155 INFLUENCE OF SELENOUREA AND OF COLLOIDAL SELENIUM ON THE SURVIVAL OF E. COLI B/r AFTER X IRRADIATION. Badiello, R. (CNR, Bologna); di Maggio, Diassina; Quintiliani, M.; Sapora, O. Int. J. Radiat. Biol.; 20: No. 1, 61-8 (1971).

E. coli B/r irradiated in the presence of 5×10^{-2} M selenourea showed an increased survival when irradiated in air and the opposite effect in nitrogen. The anoxic sensitization appeared to be due to colloidal selenium formed by radiation from selenourea, whereas the latter seemed to be a protector most active in the presence of oxygen. This conclusion was based on the following experimental results: 5×10^{-2} M selenourea solutions showed the same effect when pre-irradiated with 150 krads before mixing with bacterial suspensions; colloidal selenium separated from a repeatedly-irradiated selenourea solution and resuspended in buffer was more active than the original selenourea solution in sensitizing anoxic bacteria and completely ineffective on bacteria irradiated in air; the sensitization of anoxic bacteria was decreased by resuspending colloidal selenium in fresh selenourea solution. (UK)

58156 SURVIVAL TIME OF AZOTOBACTER CHROOCOCCUM FOLLOWING γ IRRADIATION AND IBENZMETHYZINE TREATMENT. Boige, F.; Abbatucci, J. S.; Kauffmann, J.; Goussard, J. (Univ., Caen, France). Compt. Rend. Soc. Biol.; 164: No. 11, 2229-34(1970). (In French).

Cell concentration plays an important role in determining the resistance of Azotobacter chroococcum to radiation and ibenzmethyzine. The physiological state of the cells also has an effect on their survival: cells from relatively old populations are more resistant to cytotoxic action and eventual crossing, the extra cellular medium becoming relatively toxic and intervening in selecting the more resistant cells. As a result of the intercellular recovery facilities established for Azotobacter chroococcum, the cells at the end of the culture may be assumed to arise from a particularly rich enzyme system endowing them with a greater resistance to the medium. (France)

58157 RADIOPROTECTIVE EFFECT OF ETHYLENE GLYCOL ON BACTERIA. Pleceas, M.; Romanescu, Gh.; Arizan, D.; Hlevca, B. (Inst. of Hygiene, Bucharest). Arch. Roum. Pathol. Exp. Microbiol.; 29: No. 4, 623-7(1970). (In French).

Ethylene glycol was an effective radioprotective agent against gamma irradiation of Escherichia coli. Formaldehyde and sodium merthiolate enhanced the action of gamma rays on the bacteria. (H.L.W.)

Radiosterilization and Radiopreservation

Refer also to abstract 57926.

58158 STERILIZING DOSES OF ULTRAVIOLET RADIATION AND ULTRASONIC WAVES IN TREATING WINE MICROFLORA. Avakyan, B. P. (Inst. of Viticulture and Fruitgrowing, Erevan). Biol. Zh. Arm.; 24: No. 1, 90-4(Jan 1971). (In Russian).

Various yeasts were subjected to ultraviolet light (dose was either 40,000 or 90,000 ergs/mm^2) and 20 kHz ultrasonic waves (5 to 9 sec) in an effort to develop a process of cold sterilization of the wine-making materials. Sterilizing doses of uv and ultrasound were established for their joint use in combating detrimental microflora. The irradiated microflora were quite sensitive to changes in dose of uv and ultrasound. An improvement in the wine quality was detected as a result of the use of cold sterilization. (K.S.W.)

58159 PRESENT STATUS OF NATIONAL RESEARCH PROJECT ON FOOD IRRADIATION. SPROUT INHIBITION OF POTATOES. Sato, Tomotaro (Japan Atomic Energy Research Inst., Takasaki). Nippon Genshiryoku Gakkaishi; 13: No. 3, 135-8(Mar 1971). (In Japanese).

The national research project on food irradiation was started in 1967, and is now making good progress in accordance with the program laid out for its activities. Sprout inhibition of potatoes and onions was the subject first selected for execution, and considerable study has been undertaken on the effects of irradiation and health hazards. A description is presented of the results obtained with investigations on potato, which is considered to be the most promising subject of such treatment. Large scale irradiation tests on three different varieties of potato indicated that potato sprout could be inhibited for 8 months when irradiated within 3 months of harvest to doses of 7 to 15 krad. Extensive investigations were conducted to determine the health hazards that would be occasioned by the irradiated potatoes. While the final conclusion is not yet to be reached, the results obtained so far do not indicate the existence of any problems related to health hazards associated with the irradiated potatoes. (auth)

58160 CHEMICAL AND PHYSICAL CHANGES OF DEXTRAN 40000 IRRADIATED WITH VARIOUS DOSES OF γ RADIATION. Derlikowski, Jerzy; Szyszko, Edmund; Zagorski, Zbigniew P. (Inst. for Drug Research and Control, Warsaw). Diss. Pharm. Pharmacol.; 23: No. 3, 253-7(1971).

The ^{60}Co γ radiation at doses 1.0 to 5.0 Mrad produces dose-dependent chemical and physical changes of the dry powder of dextran 40000. The doses below 1.0 Mrad do not produce such changes. As the radiodegradation of dextran 40000 is too rapid the dry powder of the preparation cannot be sterilized by ionizing radiation. (auth)

58161 MINIMUM STERILIZING DOSES OF X-RAY IRRADIATION FOR THE FIRST AND SECOND GENERATIONS OF THE RICE AND GRANARY WEEVIL. Reda Abdu; Sumarukov, G. V.; (Moscow Univ.). Vestn. Mosk. Univ., Ser. VI, Biol., Pochvoved.; 25: No. 5, 8-10(1970). (In Russian).

The effect of x-irradiation on adult rice and granary weevils was investigated with a view to ascertaining the critical dose of radiation, the sterilizing dose, and the survival rate. Doses of 8 kRad and over resulted in 100% mortality of rice weevils in 20 days, or granary weevils in 25 days. The $LD_{50/25}$ for granary weevils was 4.6 kRad; and for rice weevils 3.9 Krad. The sterilization dose for both species was 7 Krad. (KSW)

58162 EFFECT OF γ-IRRADIATED FRESH FISH ON WHITE RATS. Shillinger, Yu. I.; Osipova, I. N. Vop. Pitan.; 29: No. 5, 45-50(Sep-Oct 1970). (In Russian).

Freshly frozen fish subjected to γ irradiation in a dose of 600 krad was fed to three generations of albino rats. Any possible toxic properties of the irradiated fish and its influence on the reproductive function and progeny were studied. The irradiated fresh fish diet did not exert any marked toxic action on growth and development during three generations. There could be seen, however, a reduced activity of the blood butylcholinesterase in males of the primary generation, changes in the activity of the blood and liver aminotransferase in rats of the first generation, and depressed activity of succinate dehydrogenase and alanine aminotransferase in the liver of animals in the second generation. The irradiated fish diet had unfavorable effect on the gonads, reproductive function, and progeny, along with a certain rise in the number of intercurrent diseases in the laboratory animals. (auth)

XUM

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 59632, 60010, and 60115.

58163 (AI-AEC-12859) FUELS, MATERIALS, AND COOLANT CHEMISTRY PROGRAMS. Annual Technical Progress Report, GFY 1969. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-701. 211p. Dep. NTIS.

Research and development progress is summarized on projects devoted to materials management, helium effects and failure mechanisms in metals, integrated (n,α) cross sections by helium determinations, mechanical properties of materials in static sodium, dynamics of sodium testing, basic properties of mixed carbide fuels, radiation effects on mixed carbide fuels, sodium chemistry, and fission product contamination of sodium. (J.R.D.)

58164 UTILIZATION OF TUNGSTEN IN POLISH INDUSTRY. Ludynski, Zbigniew; Werter, Witold. Rudy Metale Niezelaz.; 16: No. 6, 282-3(1971). (In Polish).

The field of application of tungsten in domestic industry is discussed, and the present inadequate utilization of tungsten-bearing raw and waste material is critically evaluated. A proposal for a more economic use of these materials is presented. (auth)

Corrosion and Erosion

Refer also to abstracts 57519 and 59886.

58165 (AEC-tr-7237) MORPHOLOGY AND CHEMISTRY OF MAGNETITE LAYERS. Blaschke, R.; Kirsch, H.; Ottemann, J. Translated from VGB Feedwater Conference, Essen, Germany, October 7–8, 1969. 17p. (CONF-691066–1). Dep. NTIS.

Conditions for formation of magnetite layers in boilers were investigated. Information is presented on the relations of magnetite layer morphology with boiler chemistry and pressure loss in steam generators constructed of austenitic or ferritic steel. Information is also included on the morphology of Cu precipitates. (J.R.D.)

58166 (AI-AEC-12980) FUELS, MATERIALS, AND COOLANT CHEMISTRY PROGRAMS. Quarterly Technical Progress Report, July–September 1970. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-824. 48p. Dep. NTIS.

Results of investigations are reported on mechanical properties of cladding and structural materials in dynamic and static sodium, interstitial transport of C, sodium quality measurements, radioactivity transport, radiation effects on cladding and core materials, fast neutron-induced He in materials, and properties of mixed carbide fast reactor fuels. (J.R.D.)

58167 (AI-AEC-12987) FUELS, MATERIALS, AND COOLANT CHEMISTRY PROGRAMS. Quarterly Technical Progress Report, October–December 1970. (Atomics International, Canoga Park, Calif.). Contract AT(04-3)-824. 55p. Dep. NTIS.

Results of investigations are reported on mechanical properties of cladding and core materials exposed to high-temperature Na, radiation effects on cladding and structural materials, and properties of carbide fast reactor fuels. (J.R.D.)

58168 (ORNL-4676, pp 139-233) MATERIALS DEVELOPMENT. (Oak Ridge National Lab., Tenn.). Aug 1971.

In Molten-Salt Reactor Program semiannual progress report for period ending February 28, 1971.

BISMUTH—compatibility with brazing alloys at high temperatures, test program on
BRAZING ALLOYS—development of bismuth-resistant, for molybdenum alloys
CARBON—graphitization of lampblack pitch, effects of temperature on
CARBON SYSTEMS—C–Cr–Fe–Hf–Mo–Mn–Nb–Ni-base–Si–Ti–Zr, radiation effects on mechanical properties of, relations of composition with thermal neutron
COPPER—stability of MSRE salt sampling bucket of
ELECTRONS—effects on microstructure of graphite at 200 kV
FISSION PRODUCTS—deposition on MSRE graphite, evaluation by Auger electron spectroscopy
FUSED SALTS—corrosive effects on MSRE materials, status of loop tests on
GRAPHITE—stability of MSRE moderator elements of, evaluation of
—fission product deposition in MSRE, evaluation by Auger electron spectroscopy
—radiation effects on dimensions of test specimens of, in-pile
—density of, effects of processing methods on
—permeability of, effects of pyrolytic carbon sealing on
—radiation effects on dislocations in, 200-kV electron
—crystal lattice dynamics in
HASTELLOY N—radiation effects on MSRE control rod thimble of, in-pile
—stability of rods of, from MSRE sampling assembly
—radiation effects on mechanical properties of, relations of hafnium, niobium, and titanium additions with neutron
—weldability of hafnium- and zirconium-modified, using Hastelloy N weld filler
—corrosion of modified, by molten MSRE fuel salts
—corrosion by sodium fluoride–sodium fluoroborate coolant salts at high temperatures
—corrosion by high-pressure high-temperature steam
HEAT EXCHANGERS—stability of materials in MSRE, evaluation of
INCONEL 600—corrosion by sodium fluoride–sodium fluoroborate coolant salts at high temperatures
IRON A & S—coating with molybdenum and tungsten for corrosion protection, chemical vapor deposition method for
LOOPS—operation of forced-convection, for testing compatibility of Hastelloy N with molten MSRE coolant salts
MOLTEN SALT BREEDER REACTOR—fuel processing for, development of test stand for
MOLTEN SALT REACTOR EXPERIMENT—components for, evaluation of stability of
MOLYBDENUM—fabrication of MSBR fuel processing test stand components of
—vapor deposition on iron alloys by reduction of molybdenum hexafluoride
NEUTRONS—effects on mechanical properties of Hastelloy N, relations with hafnium, niobium, and titanium additions
NEUTRONS, THERMAL—effects on mechanical properties of modified Hastelloy N, relations with composition
NICKEL A & S—coating with molybdenum and tungsten for corrosion protection, chemical vapor deposition method for
SODIUM FLUOROBORATES—$NaBF_4$–NaF, corrosive effects on Hastelloy N and Inconel 600 at high temperatures
STAINLESS STEEL—corrosion of Type 304, by molten MSRE fuel salts
STEAM—corrosive effects on Hastelloy N
SULFUR—reactions with coal tar pitch, mechanisms of
TARS—reactions with sulfur, mechanisms of
TUNGSTEN—vapor deposition on iron and nickel alloys, development of methods for chemical
VALVES—stability of MSRE FV105, evaluation of (J.R.D.)

58169 (ORNL-TM-3488) MASS TRANSFER BETWEEN HASTELLOY N AND HAYNES ALLOY NO. 25 IN A MOLTEN SODIUM FLUOROBORATE MIXTURE. Koger, J. W.; Litman, A. P. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 28p. Dep. NTIS.

The compatibility of Haynes alloy No. 25 and Hastelloy N with fused $NaBF_4$–8 mole % NaF was determined in the range 605 to 460°C. The cobalt-base alloy was inadvertently incorporated in the Hastelloy N thermal convection loop and was exposed to the fluoroborate salt mixture for 3660 hr. The Haynes alloy No. 25 suffered damage by selective leaching of cobalt and chromium, which migrated to the Hastelloy N. The mechanism of corrosive attack was activity-gradient and temperature-gradient mass transfer. Haynes alloy No. 25 is more susceptible to attack by the fluoroborate mixture than Hastelloy N. The presence of the small amount of Haynes alloy No. 25 in the system did not compromise later experiments on the monometallic Hastelloy N system. Penetration of deposited cobalt corresponded to a diffusivity of 5.6×10^{-15} cm^2/sec in Hastelloy N at 465°C. (auth)

58170 (RD/B/N-1998) OBSERVATIONS ON PARTICULATES IN A SODIUM LOOP. Hayes, D. J.; Pownall, D. R.; Smith, R. J. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jun 1971. 17p. Dep. NTIS (U. S. Sales Only).

A simple sodium loop which had completed 4000 hours operation at temperatures up to 500°C was examined for particulate matter. Six types of particles were found, ranging from micron-size α-iron particles and whiskers to millimeter-size metallic foil and particles, and two types of non-metallic crystals. All were found in regions consistent with the view that their distribution is governed by fluid flow and gravitational forces. More α-iron was found than would be expected from pipework corrosion. One of the crystal types resembled sapphire and might be responsible for the valve failure found in this and other loops. (auth)

58171 HIGH-TEMPERATURE OXIDATION OF SOME OXIDATION-RESISTANT COPPER-BASED ALLOYS. Sanderson, M. D.; Scully, J. C. (Univ. of Leeds, Eng.). Oxidation Metals; 3: No. 1, 59-90(Jan 1971).

The oxidation behavior of Cu−2Be, Cu−5Al, Cu−8Al, Cu−3Si, Cu−2Al−2Si, Cu−2.5 Al−2.5 Si, Cu−4.5 Al−2Si, Cu−7.5 Al−2Si, Cu−6.5 Al−4Si, and Cu−4.5 Al−5Si, in the temperature range 100 to 800°C, in air, has been investigated by gravimetric measurements and by electron microscopical examination of stripped oxide films. Most of the alloys showed considerable resistance to oxidation. This was given mainly by a thermally grown film of γ-alumina on the Cu−Al and Cu−Al−Si alloys and by a beryllia film on the Cu−Be alloy. Other oxide phases, principally copper oxides, were also found to grow on the alloys and these are described. Silicon additions to Cu−Al alloys are found to improve their oxidation resistance, although no crystalline oxides containing silicon were observed in the oxide films stripped from the Cu−Al−Si alloys. (auth)

58172 OXIDATION OF NIOBIUM CONTAINING OXYGEN. Dekanenko, V. M.; Kornilov, I. I.; Vavilova, V. V. Izv. Akad. Nauk SSSR, Metal.; No. 6, 218-21(Nov-Dec 1970). (In Russian).

The oxidation resistance of Nb samples already containing O in solution was studied. Alloys of Nb containing O up to 5 at. % in the cast state exhibited a much greater oxidation resistance than pure Nb. Annealing at 300°C reduced the oxidation resistance, although it still remained higher than that of pure Nb. Alloys of Nb with O lying within the two-phase region, however, had a low oxidation resistance of 400°C; annealing these alloys sharply increased their rate of oxidation. The mechanisms responsible for these effects are discussed. (Metal Abstr.)

58173 SURFACE NITRIDING OF ZIRCONIUM. Samsonov, G. V.; Kaplina, G. S. Izv. Akad. Nauk SSSR, Metal.; No. 6, 222-5 (Nov-Dec 1970). (In Russian).

The surface nitriding of metallic Zr in a commercial N atmosphere cleaned of O and moisture (resultant O content 0.010 to 0.011%) was studied and the results were compared with those obtained for high-purity N. On treating in commercial N, the thickness of the nitride layers was much greater than in high-purity N, apparently as a result of the presence of oxides formed (these facilitated the diffusion of N into the growing layers of nitride). The activation energy for the diffusion on N into α-Zr was 49.7 kcal/mole in high-purity N and very slightly less in commercial N. (Metals Abstr.)

58174 METALLOGRAPHY OF THE 300 SERIES STAINLESS STEELS EXPOSED TO HIGH TEMPERATURE SODIUM. Miller, R. L.; Schrock, S. L.; Whitlow, G. A. (Westinghouse Advanced Reactors Div., Madison, Pa.). pp 105-14 of Proceedings of the Third Annual Technical Meeting of the International Metallographic Society, Inc. /Johnson, K. A. (ed.). Los Alamos, N. Mex.; International Metallographic Society, Inc. (1971).

From third meeting of the International Metallographic Society; Cleveland, Ohio (16 Nov 1970).

Chemical and metallurgical changes in the austenitic Types 304 and 316 stainless steels exposed to a high temperature, dynamic, corrosive sodium environment were investigated as part of the commercial Liquid Metal Fast Breeder Reactor (LMFBR) development program. Utilizing small, pumped-sodium loop systems, which are corrosion mockups of the reactor circuits, the formation and subsequent growth of surface depleted zones, intergranular corrosion, and elemental mass transfer in austenitic stainless steels have been monitored as a function of exposure time. Evaluation has included both optical and scanning electron microscopy, x-ray diffraction, and microprobe analysis together with a chemical milling technique. The formation of iron rich surfaces on Type 316 stainless steel and the deposition of chromium, nickel, and manganese on Type 304 stainless steel sodium-exposed surfaces have been observed metallographically. These effects are discussed in relation to their occurrence in a low oxygen (<10 ppM), flowing sodium system operating at a maximum temperature of 1325°F. (auth)

58175 KINETICS OF ZIRCONIUM OXIDATION UNDER LOW OXYGEN PRESSURES. Dechamps, M. (CNRS, Vitry-sur-Seine, France); Lehr, P.; Debuigne, J. Mem. Sci. Rev. Met.; 68: No. 4, 267-75(Apr 1971). (In French).

The study of zirconium oxidation under a low oxygen pressure by thermogravimetry revealed that the parabolic oxidation kinetics is always preceded by a short period of oxidation with linear kinetics. The mathematical interpretation given (constant rate diffusion in a semi-infinite medium) takes the duration of the linear kinetics into account. (France)

58176 WELDABILITY AND CORROSION RESISTANCE OF TITANIUM–5 PERCENT TANTALUM ALLOY. Blashchuk, V. E.; Gurevich, S. M.; Zotova, L. M.; (and others). Avtomat. Svarka; No. 6, 16-18(Jun 1971). (In Russian).

The weldability of titanium alloy 4204, containing 5% Ta, was studied with 2.5 mm stock with which seam welds had been formed with automatic argon-arc equipment. The joints were found to be satisfactory mechanically, and possessed good corrosion resistance under conditions of strain in 18% HCl at 90°C containing some free chlorine. (K.S.W.)

58177 ANODIC DISSOLUTION OF HARD ALLOYS OF THE VK TYPE [TUNGSTEN CARBIDE–COBALT] IN ALKALI–NITRATE ELECTROLYTES. Parshutin, V. V.; Petrov, Yu. N.; Loskutov, A. I. Elektron. Obrab. Mater.; No. 3, 15-20(1970). (In Russian).

The anodic dissolution of W, WC, Co, and various WC−Co alloys in an NaOH−$NaNO_3$ electrolyte was studied, and the results were compared with those obtained for the components of the electrolyte individually. The polarization curves had quite different characteristics in the different electrolytes. High potentials existing in the case of the dissolution of WC−Co alloys in $NaNO_3$, for example, were attributed to the formation of a dense oxide film impeding dissolution. In appropriately mixed solutions a state could be achieved in which both components of the alloys dissolved uniformly. (Metals Abstr.)

Preparation and Fabrication

Refer also to abstracts 57657, 57666, 57700, 58353, 58396, 59633, 59635−59639, and 60200.

58178 (AWRE-O-42/71) PREFERENTIAL DEPOSITION OF THIN SILVER FILMS INDUCED BY ELECTRON BOMBARDMENT. Stroud, P. T. (Atomic Weapons Research Establishment, Aldermaston (England)). Aug 1971. 12p. Dep. NTIS (U. S. Sales Only). UK 10p.

Deposition of silver on silica or freshly evaporated silicon monoxide is described. Electron bombardment induces the preferential deposition of silver on pure fused silica but the reverse effect is noted with evaporated silicon monoxide. Attempts are made to explain these phenomena. (auth)

58179 (CONF-711002–, pp 47-58) SAMPLE PREPARATION BY METALLURGICAL METHODS. Van Audenhove, J.; Joyeux, J. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Methods of preparing reference alloys for research centers and industries are described. Preparation techniques such as melting, shaping, canning, electrolysis, powder metallurgy, thermal reduction, and thermal treatments are described. (J.R.D.)

58180 (CONF-711002–, pp 70-6) MANUFACTURE OF CLAD FISSIONABLE FOILS FOR ZPR MEASUREMENTS. Hins, Allan G. (Argonne National Lab., Ill.). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Fabrication processes for homogeneous foil-type actinide fuel materials produced by high-precision methods are described. The fuels are contained in leaktight cladding which is corrosion resistant and tolerant of extensive handling. (J.R.D.)

58181 (CONF-711002–, pp 77-81) PREPARATION OF POWDER SAMPLES. Verdingh, V. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Preparation methods for powder samples are described including compaction, direct pressing, and sedimentation. Aspects of sample canning processes are discussed along with methods of preserving purity. (J.R.D.)

58182 (CONF-711002–, pp 122-33) PREPARATION OF STANDARD LAYERS BY VACUUM EVAPORATION. Eschbach, H. L. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

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Methods used for preparing boron and lithium standard layers and some experimental results are discussed. Preparation methods for metallic uranium foils are discussed since their preparation and subsequent definition (together with other samples) are required for exact determination of the half-life of ^{234}U. Much the same care and precaution are involved as with the neutron flux standards. (auth)

58183 (CONF-711002–, pp 160-5) PREPARATION OF LAYERS BY ELECTROSPRAYING AND ELECTROPHORESIS. Verdingh, V. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Preparation and definition of samples is one of the objectives of the Central Bureau for Nuclear Measurements. The requirements for such samples depend upon the kind of nuclear measurements to be done. In general, samples in film form must be homogeneous, adherent to the backing (if there is one) and stable over a long time. Thickness, surface area, and substrate are determined by the type of experiment; these factors together with the nature of the isotope and the quantity of starting material available largely influences the choice of the preparation method and the accuracy to which the layer can be defined. (auth)

58184 (CONF-711002–, pp 181-90) PRODUCTION AND CRYSTAL GROWTH OF ISOTOPIC RARE-EARTH METALS. Reed, R. E.; Grisham, W. B. (Oak Ridge National Lab., Tenn.). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Single crystals of the rare-earth metal isotopes ^{154}Sm, ^{163}Dy, and ^{170}Er were obtained by grain growth annealing. Crystals as large as 2.5 × 2.5 × 0.5 cm are obtainable. The purity of the starting material was very important for appreciable grain boundary migration. The impurities carbon, oxygen, nitrogen, and hydrogen had to be <500 wt ppM for best results. The presence of precipitates greatly hindered grain growth. Use of argon-filled tantalum cans for containment and as a susceptor during induction heating provided a high-pressure atmosphere during annealing and prevented loss of valuable metal isotopes. Annealing times of about 100 hr were sufficient to achieve the major part of possible grain growth. The highest annealing temperature possible without going above solid state phase transformations or melting temperatures was most effective in obtaining large grain sizes. Observations made during this study suggest that the crystals were obtained by normal grain growth. (auth)

58185 (ORNL-TM-3499) EXPERIMENTAL INVESTIGATION OF FABRICATION OF Th-20 WT. PERCENT U FOR THE UMBR FUEL ELEMENT. Copeland, G. L.; Queener, L.; Martin, W. R. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 25p. Dep. NTIS.

Results are presented of an experimental investigation designed to determine the feasibility of fabricating a Th–20 wt % U hexagonal fuel element containing hexagonal coolant channels for the Unclad Metal Breeder Reactor (UMBR). Component parts from which the fuel element may be assembled can be produced by casting or by forming from an ingot. The most attractive method of fabrication appears to be forming component parts of the element from an ingot using conventional metalworking techniques. The ingots may be produced by consumable electrode arc melting or by consolidation of blended thorium and uranium powders. (auth)

58186 (ORNL-TM-3500) TUBING FABRICATION PARAMETERS AND THEIR APPLICATION TO TEXTURE CONTROL IN ZIRCALOY TUBING. Hobson, D. O. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 43p. Dep. NTIS.

Tubing fabrication involves combinations of strains imposed upon the material to effect required dimensional changes. These strains were analyzed from the standpoint of type of fabrication operation and have produced a graphical method for plotting fabrication paths. Such a method is applicable to operations, such as tube reducing, in which the inside surface dimension of the tubing is controlled throughout the fabrication step. Other operations, such as rod-mandrel drawing, required additional analysis of the true strains involved. Texture formation in Zircaloy tubing is dependent upon the ratio of true wall thickness strain to true circumferential strain at any point in the tube wall. The texture formation was characterized with fabrication parameters and showed how texture control can be achieved with all common fabrication processes. (auth)

58187 (SCL-T-710281) POSSIBLE USES OF PLASMA IN POWDER METALLURGY, WITH PARTICULAR REFERENCE TO SPHEROIDIZATION. Rutkowski, Wladyslaw; Szteke, Witold (Institute of Nuclear Research, Warsaw (Poland)). Translated for Sandia Labs., Livermore, Calif., from report INR-938. 43p. Dep. NTIS.

A discussion is presented on aspects of applying plasma in powder-metallurgical processes, application of powders to other processes with the use of plasma, and the application of other products of powder metallurgy in plasma processes. Results obtained with the spheroidization of Al_2O_3, Ta, and Ni powders are presented, as are the results of metallographic and microscopic investigations on these powders. (auth)

58188 (ZJE-110) SOME REMARKS CONCERNING ZIRCONIUM ALLOY WELDING. Sika, J. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1971. 20p. Dep. NTIS (U. S. Sales Only).

Aspects of zirconium alloy welding directed especially toward shielded welding using the TIG-method or electron beam welding are examined. Experimental welding results are given which have been achieved first on substitute materials and afterwards mainly on the C2M zirconium alloy up to a thickness of 1 mm. A brief description of the welding equipment, protection chamber with preliminary vacuum treatment, the ES-2 electron welding machine is given which indicates the possibilities of welding fuel element cans from zirconium alloy. (auth)

58189 KINETICS OF THE REDUCTION OF TUNGSTEN AND MOLYBDENUM TRIOXIDES BY HYDROGEN. Chizhikov, D. M.; Rather, Yu. E.; Tsvetkov, Yu. B. Izv. Akad. Nauk SSSR, Metal.; No. 6, 8-13(Nov-Dec 1970). (In Russian).

The reduction processes of tungsten and molybdenum trioxides proceed in stages with the formation of a series of intermediate products. Stages in the processes are confirmed by studies of the electric conductivity of the restored oxide phases. The presence of water in the gas phase has different effects on the kinetics of the reduction processes for the trioxides of tungsten and molybdenum. The increase in the ratio $H_2O:H_2$ in the gas phase accelerates the reduction process for tungsten trioxide and slows down the process for MoO_3. On the reduction of WO_3 by hydrogen with increased water content in the gas phase, metallic tungsten powder particles expand. The presence of water vapor in the gas phase has no pronounced effect on the coarseness of metallic Mo powder produced by the reduction of MO_3. (tr-auth)

58190 ETCHING OF METALLOGRAPHIC SPECIMENS BY CAVITATION. Young, Stanley G. (Lewis Research Center, Cleveland). pp 167-85 of Proceedings of the Third Annual Technical Meeting of the International Metallographic Society, Inc. /Johnson, K. A. (ed.). Los Alamos, N. Mex.; International Metallographic Society, Inc. (1971).

From third meeting of the International Metallographic Society; Cleveland, Ohio (16 Nov 1970).

A vibratory technique employing a magnetostrictive transducer was used to determine the cavitation damage in distilled water to several unalloyed metals and one nickel-base superalloy at room temperature. Some of the unalloyed metals studied were too soft to withstand the forces generated within a specimen when it was ultrasonically vibrated. Therefore, a technique was used in which the specimens were held stationary beneath an ultrasonically vibrated head, and cavitation damage was caused to the specimen by a cavitating cloud formed between the vibrating head and the stationary specimen. The specimens were polished metallographically before testing and examined at several time intervals during tests. Preferential damage at grain boundaries and other metallurgical features were observed in the unalloyed metals as a result of cavitation attack. Structural features of the complex alloy, Udimet 700, were clearly revealed. The results indicate that cavitation may be useful as a technique for selective etching of materials. The weaker phases would be removed, leaving the tougher, harder, impact resistant phases. This method would also allow the investigator to easily recover material from the distilled water (or any other fluid desired) for further analysis without the disadvantages associated with the use of reactive chemicals. (auth)

58191 URANIUM INDUSTRY WITH REALISTIC CONCEPTS OF CONSUMPTION. Guenzel, H.; Knoerr, B. K. Metall; 25: No. 7, 825-8(Jul 1971). (In German).

Recent developments, especially during the last two years, demonstrate that a free economy rapidly develops new markets, and finds means for discovery and utilization of necessary material. This fact is evidenced by the finding of significant uranium depisits. In the future, the cost of U_3O_8 will be determined more than previously by the mineral content of the accessible ore. Also, the interest will turn toward other fuel cycles, such as thorium, and, thereby, create competition between raw materials for nuclear energy. Safe predictions are premature because of the many technical problems that still await solution. (tr-auth)

58192 PURIFICATION OF VANADIUM AND PRODUCTION OF VANADIUM SINGLE CRYSTALS THROUGH ZONE MELTING. Bressers, J. (Kommission der Europaeische Gemeinschaften Gemeinsame Forschungsstelle Forschungsanstalt, Petten, Netherlands); Heerschap, M.; De Meester, P. Metall; 25: No. 7, 765-9(Jul 1971). (In German).

A zone melting method is described which permits purification of vanadium as well as production of oriented single crystals. A technique is also described for tensile testing of the single crystals by the melting of spherical heads on the crystals. An analysis of interstitial impurities reveals that zone melting strongly reduces the oxygen content. Carbon content decreases not as strikingly, and nitrogen content remains constant. The degree of purity of the obtained vanadium is established by determination of rigidity, specific electric resistance, and other flux measurements. (tr-auth)

58193 ELECTRIC-EROSION MACHINING OF DEEP CYLINDRICAL APERTURES [IN METAL PARTS]. Foteev, N. K. Elektron. Obrab. Mater.; No. 3, 9-15(1970). (In Russian).

The conditions required for machining deep cylindrical apertures up to 10 mm in dia with a depth/dia ratio of 10 to 250 by the electric-erosion method in metal parts (Mo, Nb, heat-resistant Ni alloys) are discussed in the light of practical experience. Some particular metallographic analyses of apertures drilled by this method in these metals are presented. Practical recommendations are made for optimizing the machining process. (Metals Abstr.)

58194 CONSTRUCTIONAL COMPONENTS FOR THE REACTOR CORE IN NUCLEAR POWER GENERATION. Kobe Seiko Giho; 20: No. 2, 66-9(Apr 1970). (In Japanese).

Kobe Steel Ltd. has engaged in the technology development for construction of the nuclear power-generation reactor core components. These include a channel box of BWR plants which is used to regulate coolant flow and is made of Zircaloy-4. The procedure of its manufacture is by bending the plate in the form of a U and subsequent welding. Stainless steel cladding tubes for nuclear-powered ships are described including the chemical composition, tensile properties, and dimensions required. Stainless steel cladding tubes for AGR's are also described. Pressure tubes and calandria tubes for the ATR are being developed in Japan composed of Zr/2.5% Nb alloy and Zircaloy-2, respectively. Stainless steel cladding tubes, wrapped with wire to ensure efficiency of the cooling channels and wrapper tubes to maintain the fuel spacing, for the FBR are being developed which are made of AISI 316 stainless steel. (Japan)

58195 LUBRICATION ASPECTS OF THE DEEP DRAWING OF STAINLESS STEEL, TITANIUM, AND NICKEL-BASE ALLOYS AT ELEVATED TEMPERATURES. Pope, Malcolm H.; Robins, Leonard; Berry, John T. ASLE (Amer. Soc. Lubric. Eng.) Trans.; 13: No. 2, 148-58(Apr 1970).

A range of potential lubricants was examined in friction and actual cup-forming tests on AISI 304, Inconel X and Ti−6Al−4V. Among these potential lubricants were boron nitride, two graphitic materials and two oxides of Mo. The latter two materials appear to be promising at temperatures above 900°F. Further development work is being undertaken. (Metals Abstr.)

58196 MILLING [OF A SPECIMEN] SURFACE HARDENED BY A CHROMIUM–TUNGSTEN WIRE [HARD-FACING PROCESS]. Kaganovich, D. I. Stanki Instrum.; No. 9, 41-2(Sep 1970). (In Russian).

A surfacing process using fused Cr−W wire is widely used to improve the heat-resistant and wear-resistant properties of metallurgical plant equipment. The surface layer containing C 0.3, Cr 2.5 to 3.0, W 8.5 to 10.0, Mn 1.0, and V 0.3% is difficult to machine. VK-group alloy cutting tools are usually used. Productivity can be improved by pre-heating the surface to a relatively low temperature (100 to 150°C) both for machining and milling. (Metals Abstr.)

58197 HOT ISOSTATIC PRESSING. Johansson, R.; Isaksson, S.-E. Powder Met. Int.; 2: No. 2, 49-50(Jun 1970).

Manufacture of high-speed tool steels and tungsten carbides by means of hot isostatic pressing is described. The conventionally made high-speed tool steel shows a great tendency toward segregation and irregular coarse-grained structure. By manufacturing high-speed tool steel out of powder, a material with a very fine structure is achieved. The carbide grain size is 1 μm or smaller and segregations are eliminated. Hot isostatic pressing has increased the life of high-speed tool-steel drills by 400%. Tungsten carbide is a dense material but often contains pinholes that reduce the tensile strength. A reduction of pinhole volume led to an increase in the life of certain types of high-pressure dies. (Metals Abstr.)

58198 MILLING [CHARACTERISTICS] OF A HIGH-TEMPERATURE NIOBIUM ALLOY. Ivanov, A. P.; Dryakina, I. P. Stanki Instrum.; No. 6, 40-1(Jun 1970). (In Russian).

Although Nb-base alloys have a range of valuable constructional properties and belong to a group of materials with a promising future, they are not widely used owing to the sparse nature of published information concerning their technical characteristics and mechinability. Investigations were therefore carried out into the milling of a typical high-temperature Nb-base alloy, VN-3. This is a Nb−Mo−Zr alloy containing nitride, carbide, oxide, and hydride inclusions dispersed in the grains and grain boundaries; UTS = 70 to 80 kg/mm^2. Experiments were carried out on flat, 80 × 8 mm specimens with a cutting tool of R18 steel. Temperature measurements were made by the natural thermocouple method (cutting tool/workpiece) and recorded on an oscillograph. The dynamics and temperature of milling were studied over a wide range of cutting speed, feed, and depth of cut and the results presented in a series of graphs. Experiments were also carried out at −196°C in liquid N. (Metals Abstr.)

58199 METALWORKING. Olofson, C. T.; Byrer, T. G.; Boulger, F. W. (Battelle Memorial Inst., Columbus, Ohio). DMIC Rev.; 4p.(12 Aug 1970).

A report is given on two programs to develop manufacturing processes for dispersion-strengthened alloys; one is concerned with fabricating TD Ni−Cr tubing to sizes of 0.3125-in. OD × 0.035-in. wall, 0.25-in. OD × 0.020-in. wall and 0.156-in. OD × 0.020-in. wall; the other is to develop sheet-fabrication practices for TD Co−Ni−Cr alloys in thicknesses of 0.075, 0.050, and 0.020 in. Other studies include the use of molten A-47 glass for heat treating forging stock of Ti−6Al−6V−2Sn alloy and 4340 alloy steel; rolling of tapered Ti−6Al−4V alloy plate; and fabrication of 0.005-in. dia Be wire and thin-wall Ti−6Al−4V alloy tubes by hydrostatic extrusion drawing. Metal-cutting studies include work on machining stainless steel, mild steel and pure Ti at cryogenic temperature, finish machining of medium-C steels in O, N, and Ar atmospheres and effects of Al and S contents on the tool life in the screw machining of Type 303 stainless steel. (Metals Abstr.)

58200 ACTIVATED SINTERING. Barta, J. Powder Met. Int.; 2: No. 2, 52-4; 56-7(Jun 1970).

"Activated sintering" would involve physical or chemical changes related to the sintering material which would cause a significant decrease in sintering time and/or temperature as compared with a known procedure. Theories of sintering are considered and it is shown that to increase sintering rates, that is, to "activate" sintering, it is necessary to increase the driving forces for sintering and to decrease the resistance to material transport. Experimental data are presented for Ni, MgO, W, and others to substantiate theories of activated sintering. It is concluded that the available theories and basic data do not allow an unequivocal evaluation of the experimental data. Furthermore, it is shown that "activated sintering" might be meaningful only within a technological frame of reference; theoretically, "activated sintering" is sintering carried out at selected values of sintering parameters and is, in principle, not different from ordinary sintering. (Metals Abstr.)

58201 JOIN EXOTIC MATERIALS IN SECONDS WITH CONTINUOUS SEAM DIFFUSION BONDING. Metcalte, Arthur G.; Goad, Robert C. Machinery (N. Y.); 76: No. 15, 54-7(Nov 1970).

Continuous seam diffusion bonding can continuously and quickly join Ti, Ti alloys, Hastelloy X, 17-4PH stainless steel, TD-NiC, Nb alloys, and other high-strength materials without using an intermediate layer or requiring caskets, filler blocks, and heating furnaces. The bonding machine is equipped with opposed hot rotating wheels that are adjustable for height, temperature, and drive speed. High-strength joints are produced in complex shapes or laminated parts. (Metals Abstr.)

58202 OPEN ALUMINOTHERMIC REDUCTION OF COLUMBIUM (Nb) PENTOXIDE AND PURIFICATION OF THE REDUCED METAL. Kamat, G. R.; Gupta, C. K. (Bhabha Atomic Research Centre, Trombay, India). Met. Trans.; 2: No. 10, 2817-23(Oct 1971).

This investigation is concerned with the extraction of Nb metal by aluminothermic reduction of its pentoxide in a refractory-lined open reactor. Reduction with 15% of aluminum in excess of stoichiometric and priming at the center are found to be optimum parameters. Trials with 3-kg batches of niobium oxide have resulted in high yields of consolidated Nb. Aluminum-reduced Nb has been

XUM

further processed by electron-beam melting—after prior pyrovacuum treatment for removal of aluminum, and also directly—and in either case it has been possible to produce pure and ductile Nb. The investigation proceeds to evaluate fused salt electrorefining of the reduced Nb employing $NaCl-KCl-K_2NbF_7$ bath. Conditions for operating the cell at 90% or more current efficiency have been established. Electrorefining has been found to be effective in lowering of most of the impurities in the anode feed. Electrolytic Nb on consolidation by electron-beam melting is found to have a hardness value of 50 Dph. (auth)

58203 NICKEL- AND COBALT-BASE ALLOYS. Simmons, W. F.; Beuhring, V. F. (Battelle Memorial Inst., Columbus, Ohio). DMIC Rev.; 5p.(17 Jul 1970).

Recent research on Ni and Co alloys includes work on: cast Ni superalloys containing Re, Mn, Y, Ce, Gd, Th, and La to improve oxidation and hot corrosion resistance; a turbine-blade casting alloy containing Cr, Al, W, and Mo for optimum properties in thin sections; high-temperature compressive yield strengths and hot hardnesses of heat-resistant Co and Ni alloys; mechanisms used to strengthen Ni-base superalloys; turbine-vane applications for the thoria-containing alloys $Co-20Ni-18Cr-2ThO_2$ and $Co-20\,Ni-30Cr-2ThO_2$; effect of very low-S levels in fuel on the hot corrosion of turbine-blade alloys; effect of different Cr: Al ratios on the oxidation in air or O of Ni alloys at 800 to 1300°C; oxidation resistance of WI-52 and IN-100 superalloys in static air at 1500 to 2000°F; and oxidation resistance of Co superalloys WI-52 coated with a commercial aluminide coating. (Metals Abstr.)

58204 SIGNIFICANCE AND USE OF INTERMEDIATE LAYERS DURING WELDING AND METAL SPRAYING [OF DISSIMILAR METALS]. Wirtz, Heribert. Schweissen Schneiden; 22: No. 10, 417-21(Oct 1970). (In German).

The requirements and properties of intermediate layers, which are used when joining and coating dissimilar metals are discussed. For example, when welding pure Cu to mild steel or low-alloy steel, a 2- to 5-mm-thick intermediate layer of weld deposit S-NiCr-15Fe-10Nb is provided. Materials used for intermediate layers when joining steel to various alloys e.g., Cu–Zn, Cu–Sn, Cu–Si, Cu–Al, Cu–Ni, are described and also steel to Al. Steel clad with X 10 CrNiTi 18 9, and lamellar-graphite cast-iron weldments are also considered. Satisfactory joints between dissimilar metals can be achieved if the instructions given (with regard to the intermediate layer) are carried out both during manufacture and repair welding. (Metals Abstr.)

58205 SPECIAL WELDING PROBLEMS MET DURING THE MANUFACTURE OF FUEL ELEMENTS FOR THE SUPERHEATED-STEAM REACTOR AT GROSSWELZHEIM. Zutz, Lothar; Busch, Herbert. Schweissen Schneiden; 22: No. 11, 461-4(Nov 1970). (In German).

The fuel element and fuel element components of superheated-steam reactors (HDR) are described and brief details are given of the various types of welding operations involved in their manufacture e.g., TIG, electron-beam welding, various soldering techniques and tube cladding e.g., with Zircaloy-2 on Cr–Ni steel or vice versa. The main material used in fuel element manufacture is Inconel 625 and the welding-fabrication, nondestructive and destructive testing techniques used are described. A special TIG-welding machine enables the welding parameters to be controlled since extra care must be taken during welding because of the high degree of loading to which fuel-element components are subjected. (Metals Abstr.)

58206 TUNGSTEN NEWS, AUGUST 1971. Tungsten News; 1-18(Aug 1971).

Activities associated with manufacture and use of W are reviewed. Information is included on the agenda of a metallurgy seminar, properties and uses of W, properties and uses of WC, properties and uses of W-base alloys, processing of W ore concentrates, and properties of W compounds. 300 references are included. (J.R.D.)

58207 DIFFUSION BONDING: METHODS AND APPLICATIONS. III. METAL-JOINING PROBLEMS. Alm, Gerald V. Adhes. Age; 13: No. 9, 31-6(Sep 1970).

Difficult applications of diffusion bonding include: solid-state bonding of PbTe thermoelectric material in a nuclear reactor to a series of metals and alloys such as Cu, Fe, Al, and 62Ag–24Cu–14In; joining of intricately finned Al extrusions to the OD and ID surfaces of U alloy fuel tubes; diffusion bonding of Al cold plates and thermal conditioning panels for the Apollo and Saturn launch vehicle; bonding of Al/stainless steel tubular transition joints; diffusion bonding of 0.006-in. thick Al foil to a 21-in. dia piston wall of 6061 Al alloy; diffusion bonding of a Ti–6Al–4V alloy bellows and roll bonding of clad nuclear-reactor fuel elements and corrugated-core aerospace structures. A table lists advantages and limitations for joints between broad, flat surfaces, tube and bar butt joints, line contacts, and interfaces between tubes. (Metals Abstr.)

Properties Evaluations

Refer also to abstracts 57297, 57610, 57614, 57635, 57644, 57654, 57662, 59194, 59197, 59640, 60058, 60061, 60075, and 60118.

58208 (AECL–3967) DIFFUSION COEFFICIENT AS A GUIDE TO PROSPECTS FOR HIGH-TEMPERATURE ZIRCONIUM ALLOYS. Carpenter, G. J. C. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jun 1971. 30p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

The high-temperature creep deformation of metals and alloys was reviewed in an effort to obtain a perspective on prospects for high-temperature zirconium alloy development. It was concluded that the most important factor that limits resistance to stress at high temperatures is the rate of self-diffusion. This is more important than other fundamental physical properties of zirconium involved in deformation, namely the elastic modulus and the stacking fault energy. Since it is possible, in principle, to include similar obstacles to dislocation motion in any metal, the self-diffusion coefficient can be used as a guide to the high-temperature potential for zirconium. On this basis, α-zirconium appears to behave as if it had an effective melting point of about 1500°C. This is close to a value calculated by A. J. Ardell (Acta Met., 11, 591 (1963)) from thermodynamic considerations. It is suggested that a rough guide to the long term development prospects for dilute zirconium alloys based on conventional alloying techniques can be obtained by looking at the creep properties of the low alloy ferritic steels. These steels are available with a creep rate of $\sim 10^{-7}$/hour under a stress of 10,000 psi at temperatures up to 600°C. (auth)

58209 (AECL–3992) MATERIALS RESEARCH IN ATOMIC ENERGY OF CANADA LIMITED. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Spring 1971. 21p. Dep. NTIS (U. S. Sales Only).

ALUMINUM OXIDES—fatigue properties of, calculations from model of Griffith cracks
CRACKS—propagation of Griffith, thermodynamic-kinetic model of
CREEP—determination of in-reactor, from stress relaxation experiments
DIFFUSION—short-circuiting effects in solids
MATERIALS TESTING, DESTRUCTIVE—methods for zirconium alloy fuel cladding and pressure tubes
REACTOR FUEL ELEMENTS—cladding for, closed-end burst testing of
SOLIDS—diffusion in, short-circuiting effects in
URANIUM SILICIDES—radioinduced swelling of U_3Si
ZIRCONIUM ALLOYS & SYSTEMS—testing of fuel cladding of, closed-end burst
—testing of, in-reactor stress relaxation
—mechanical properties of fuel cladding and pressure tubes of
—plastic instability of tubes of (D.L.C.)

58210 (IS-T–490) CAPILLARY-RESERVOIR DIFFUSION STUDIES IN Hg–In ALLOYS UTILIZING CONTINUOUS RESISTIVITY MEASUREMENT OF COMPOSITION. Kaiser, Robert Hamilton (Ames Lab., Iowa). Sep 1971. Contract W-7405-eng-82. 95p. Dep. NTIS.

Thesis.

A capillary-reservoir diffusion cell has been designed to follow the process of liquid metal diffusion in the capillary on a continuous basis. Molybdenum electrodes were located at intervals along the capillary so that the composition could be monitored by noting the change in resistivity of the capillary contents. These probes were in the form of annuli with respect to the capillary which enabled the measurement of resistances without obstructing the diffusion process. This cell was used to measure the composition dependence on the diffusion coefficient in the mercury-indium system at 25°C. Compositions up to 13.19 at. % indium were investigated. The summary equations relating composition in atomic fraction indium and diffusivity in cm²/sec for two capillary sections are as follows: Section 2 $D = 3.00 \times 10^{-5}\,\overline{N} + 1.48 \times 10^{-5}$, Section 3 $D = 2.80 \times 10^{-5}\,\overline{N} + 1.30 \times 10^{-5}$. When compared with previous data on indium amalgams, the results indicate that the technique is adequate. (auth)

XUM

58211 (LA–4758) THERMODYNAMIC PROPERTIES OF $PuRu_2$ FROM EMF MEASUREMENTS. Campbell, George M. (Los Alamos Scientific Lab., N. Mex.). Sep 1971. Contract W-7405-eng-36. 4p. Dep. NTIS.

Non-stationary emf techniques were used to ensure reversibility and singularity of electrode reactions in the emf cell $Pu(l)/PuCl_3$, $LiCl-KCl/PuRu_2 + Ru(s)$ at temperatures between 913 and 1078°K. The free energy of formation of $PuRu_2$ at 1000°K was found to be $\Delta G_{f1000} = -8.08 + 0.0013$ T kcal/mole. Thermodynamic properties were estimated at lower temperatures. (auth)

58212 (NRCN–268) A STUDY ON DIFFUSION OF Co IN Pu. Daft, M. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev). Aug 1970. 153p. (In Hebrew). INIS.

As plutonium is used widely as a fuel, it is important to study its properties at high temperature. Many of the processes in these conditions are diffusion mechanisms. The solute was ^{60}Co, and the problems of vaporizing it are discussed. Some experiments were carried on γ-uranium and β-uranium and gave results that corresponded to those in the literature, and this proved that the methods used were suitable. The experiments were carried on: ϵ-plutonium at 506°C, delta phase Pu at 340°C to 400°C, δ phase Pu–9% Al alloy and ϵ-gold-198–Pu alloy. (INIS)

58213 (ORNL-TM–3350) STUDY OF THE FORMATION OF CREEP CAVITIES IN POWDER-METALLURGY TUNGSTEN. Stiegler, James O. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 200p. Dep. NTIS.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

At elevated temperatures metals suffer a loss in ductility brought about by the formation of grain-boundary cracks. Details of the nucleation and growth of these cracks in tungsten produced by a powder-metallurgy process were studied by electron fractography. Creep tests were interrupted and the specimens fractured at room temperature to expose any cavities or cracks formed at high temperatures for examination. After an annealing treatment of one hour at 1600°C the grain boundaries of the tungsten were populated by about 10^7 gas bubbles per square centimeter averaging approximately 0.2 μm in diameter. The bubbles were distributed nonrandomly, and there were large variations in bubble size and distribution. Different grades of tungsten showed different grain-boundary structures. Under stress at 1600°C these bubbles expanded. At low stresses they grew slowly and maintained equiaxed, crystallographic shapes. At high stresses they grew rapidly in the plane of the grain boundary and formed irregular, flat cavities about 1 μm thick. These cavities tended to grow rapidly in certain directions but always with blunt ends. No evidence of cavities nucleated by deformation was obtained, but a few rare cases of possible triple-grain junction cracks were found. Only a slight tendency for spheroidization of the flat cavities was noted for annealing times as long as 100 hours at 1600°C. The model most in agreement with these observations is one in which the gas bubbles expand to form the cavities by the stress directed diffusion of vacancies along the grain boundaries. At low stresses this occurs slowly enough that the cavities are able to maintain equiaxed shapes by the process of surface diffusion. When the growth rate exceeds some critical value, surface diffusion no longer can occur rapidly enough, and the cavities grow in the plane of the boundary. Their irregular shapes suggest that the average stress does not direct their growth but that local variations in stress possibly resulting from grain-boundary sliding or deformation within the grains are responsible. The wedge-like cracks observed with the optical microscope arise when the flat cavities reach a triple-grain junction and are opened into a wedge by sliding on the adjacent grain boundaries. This model reconciles the conflicts in some of the previous models for crack formation. Since the specimen elongates as the cavities expand, their growth constitutes a creep mechanism. The creep rate from the diffusion-controlled growth of equiaxed cavities is in order-of-magnitude agreement with measured creep rates for materials containing cavities. The creep rate from growth of cavities in the concentrations present in the powder-metallurgy material used in this work is about two orders of magnitude faster than Nabarro–Herring diffusional creep would occur in the same material. Some unusual observations made on a powder-metallurgy tungsten–25% rhenium alloy which deformed at a faster rate at 1650°C than at 2200°C at a stress of 500 psi are explained semiquantitatively by this model of creep due to cavity growth and the observed microstructural features. The characteristics of creep by cavity growth are also described. (auth)

58214 (RD/B/N–2023) NUCLEATION OF ATOMIC STEPS ON INERT GAS BUBBLES INTERSECTED BY DISLOCATIONS. Beere, W. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jun 1971. 18p. Dep. NTIS (U. S. Sales Only).

The diffusivities of small polyhedral bubbles attached to dislocations in copper thin foils were calculated from observations of the distances migrated and the rate of diffusion to the foil surface during isothermal annealing. It was shown that when few collisions occur between bubbles the bubble diffusivity could be easily calculated from the experimental data. The bubble diffusivities were satisfactorily described by a rate controlling nucleation mechanism, in which ledges, introduced into the bubble surface by the dislocation, rotated about the dislocation causing the bubble to migrate. The model predicted that bubbles intersected by dislocations would have higher diffusivities than bubbles in a perfect lattice. (auth)

58215 (Y-DA–4280) SCANNING ELECTRON MICROSCOPY OF FRACTURES IN WELDED STRUCTURES. Lundin, Carl D.; Bennett, Robert K. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 14 Sep 1971. Contract W-7405-eng-26. 19p. (CONF-710902–5). Dep. NTIS.

From fourth annual meeting of the International Metallographic Society; Denver, Colo. (21 Sep 1971).

The scanning electron microscope has been used to observe and characterize the morphology of the surfaces of weld defects, discontinuities, and fractures. These observations and characterizations have enabled the definition of the mechanism of formation of weld defects and have provided information as to the factors leading to the formation of weld fractures. In nickel-base alloys hot cracking is easily and clearly recognized by scanning electron fractography. In most cases a liquid film is an integral part of the cracking mechanism, and other evidence suggests that at times two liquid films of differing compositions and properties play a part in the mechanism of crack formation. Evidence is also available which suggests the possibility of a stress-rupture mechanism of hot crack formation in which a previously solidified film plays a role. In molybdenum and molybdenum base alloys, clear evidence has been obtained that the majority of hot crack formations during welding is influenced by liquid films. A second mechanism of elevated temperature fracture in these alloys has been determined to result from void formation on grain boundaries and link-up of voids to form microfissures and subsequent boundary fracture. (auth)

58216 (ZJE–106) DEVELOPMENT OF PRESSURE VESSEL STEELS FOR CZECHOSLOVAK NUCLEAR POWER STATIONS. Becka, J.; Brumovsky, M.; Filip, R.; Indra, J. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1971. 25p. Dep. NTIS (U. S. Sales Only).

The basic characteristics of five types of steels which were developed and studied for nuclear reactor pressure vessels are reviewed. Effect of initial size of defects on the initiation of brittle-fracture and of radiation damage are taken into account. (auth)

58217 (ZJE–107) PROPERTIES OF ZIRCONIUM ALLOYS FROM THE OPERATION STANDPOINT. Filip, R.; Velkoborsky, J. (Skoda Works, Pilsen (Czechoslovakia). Nuclear Power Construction Dept.). 1971. 20p. Dep. NTIS (U. S. Sales Only).

The selection of zirconium alloys for the active zone of the gas-cooled heavy water reactor is discussed along with classification and properties of these alloys from the technical standpoint. Information is given about the technique of zirconium alloys evaluation in relation to their creep and, furthermore, about specific properties of the experimental testing equipment. (auth)

58218 TENSILE AND IMPACT PROPERTIES OF THICK-SECTION PLATE AND WELDMENTS. Canonico, D. A.; Berggren, R. G. (Oak Ridge National Lab., Tenn.). Nucl. Eng. Des.; 17: No. 1, 4-15(1971).

Most nuclear pressure vessels have been fabricated from ASTM A533, grade B, class 1 steel plate. This steel is quenched and tempered in order to obtain its optimum properties in section sizes from 6 to 12 in. in thickness. The quench-and-temper heat treatment results in a variation in mechanical properties through the thickness of the plate. The room temperature ultimate tensile strength varies from nearly 97,000 psi at the plate surface to about 89,500 psi at the midsection ($\frac{1}{2}$ T). The greatest effect of the quench is observed in the nil ductility transition temperature. The 30 ft lb Charpy V-notch temperature varies from –150°F at the surface to +10°F at the $\frac{1}{8}$ T location. Anisotropy due to the rolling is reflected in the upper shelf values of the longitudinal, transverse, and through-the-thickness properties of the plate. These values are 115, 100, and 80 ft lb, respectively, for the three directions. Three welding processes are employed in the fabrication of the pressure vessels. These are the submerged arc (subarc) process, the shielded metal-arc process, and the electroslag process. The sub-

XUM

arc and shielded metal-arc processes employ multipass welding techniques and the weldments resulting from these processes are only stress relieved after welding. The electroslag weld consists of a coarse-grained (ingot-like) structure which is unacceptable in the as-welded condition. The electroslag weldment is quenched and tempered after welding. The ultimate tensile strength of the welds is uniform through their thicknesses. Their ultimate tensile strengths are all similar, about 80,000 to 85,000 psi. The impact properties of the electroslag and multipass weldments are not similar. The electroslag weld metal has an upper shelf Charpy V-notch energy of about 80 ft lb, whereas the multipass welds (subarc and shielded metal-arc) have shelf values of from 120 to 150 ft lb. Further, the 30 ft lb C_V temperature of the subarc and shielded metal-arc welds are near –50 to –70°F. The temperature for the electroslag weld metal for the same energy value is –20°F. (auth)

58219 TESTING THE SIX-INCH THICK FLAWED TENSILE SPECIMEN FOR THE HEAVY SECTION STEEL TECHNOLOGY PROGRAM. Grigory, Stephen C. (Southwest Research Inst., San Antonio, Tex.). Nucl. Eng. Des.; 17: No. 1, 161-9(1971).

The 15 million pound tensile test facility at Southwest Research Institute has been used to test a series of large tensile specimens for the Heavy Section Steel Technology (HSST) Program. These specimens are A533 grade B, class 1, and are 6 in. thick, 18 in. wide, 4 ft long and contain flaws. The procedures used to create the flaws are discussed and pertinent data for six tests at temperatures from 50°F to 220°F and requiring loads up to 7.5 million pounds for failure are presented. (auth)

58220 ACTIVITY OF ALUMINUM, VANADIUM, AND CHROMIUM IN BINARY TITANIUM ALLOYS. Rubtsov, A. N.; Olesov, Yu. G.; Cherkashin, V. I.; Suchkov, A. B. Izv. Akad. Nauk SSSR, Metal.; No. 6, 84-7(Nov-Dec 1970). (In Russian).

The activities of Al, V, and Cr in Ti–Al, Ti–Cr and Ti–V alloys subjected to successive hydrogenation and dehydrogenation for refining purposes were determined by the emf method and correlated with the activities of Ti in the corresponding materials. The activity of Ti was much greater in hydrogenated alloys. This effect was attributed to the rupture of the bonds between the Ti and the alloying elements. By taking advantage of this effect the removal of unwanted elements from Ti may be greatly facilitated. (Metals Abstr.)

58221 STUDY OF THE GAS EVOLUTION AND MECHANICAL PROPERTIES OF MOLYBDENUM WIRE. Nechiporenko, E. P.; Kirillov, V. S. Izv. Akad. Nauk SSSR, Metal.; No. 6, 128-34(Nov-Dec 1970). (In Russian).

The effect of annealing temperature and vacuum treatment on the mechanical properties of Mo wire and on the amount of gas evolved from the metal was studied. A 10-min vacuum anneal at 750 to 1500°C sharply reduced the yield strength and increased the ductility, the relative elongation after annealing at 1500°C being >50%. Anomalous grain growth occurred during annealing and the C content diminished; these effects were detrimental and favorable respectively towards the ductility. (Metals Abstr.)

58222 STUDY OF CREEP IN NIOBIUM–MOLYBDENUM ALLOYS. Prokoshkin, D. A.; Vasil'eva, E. V.; Tret'yakov, V. I. Izv. Akad. Nauk SSSR, Metal.; No. 6, 146-50(Nov-Dec 1970). (In Russian).

The creep characteristics of Nb–5 to 20 wt. % Mo alloys were studied at 1100 to 1300°C for stresses of 10 to 30 kg/mm^2. There was a regular decrease in creep velocity (steady creep section) with increasing Mo content, apparently as a result of a reduction in diffusion mobility. The velocity of steady creep varied with applied stress in accordance with a power relationship, the power index rising from 2.8 to 4.6 with increasing Mo content over the range studied. The activation energy for steady creep rose from the value corresponding to the self-diffusion of pure Nb to much higher values with increasing Mo content. (Metals Abstr.)

58223 STUDY OF HARDENING DURING THE FATIGUE OF VARIOUS PURE METALS [ALUMINUM, CADMIUM, ETC.]. Shetulov, D. I.; Magidov, M. B.; Myasnikov, A. M.; Shibarov, V. V.; Sokolov, L. D. Izv. Akad. Nauk SSSR, Metal.; No. 6, 165-9(Nov-Dec 1970). (In Russian).

Changes taking place in the strength, hardness, ductility, and microstructure of a number of metals (Al, Cd, Zn, Cu, Fe, and Ti) during fatigue (alternating stresses) were studied, the corresponding fatigue diagrams being plotted and correlated with structural changes. The slopes of the fatigue curves correlated directly with the stacking-fault energy of the corresponding materials (the higher the stacking-fault energy, the steeper the curve). This result is discussed in terms of hardening theory. (Metals Abstr.)

58224 HEAT RESISTANCE OF NICKEL-BASE ALLOYS. Ryabtsev, L. A.; Pryakhina, L. I.; Ignatov, D. V. Izv. Akad. Nauk SSSR, Metal.; No. 6, 190-1(Nov-Dec 1970). (In Russian).

The heat resistance of Ni–Al alloys of various compositions was studied. The heat resistance of the γ' solid solution, based on the chemical compound Ni_3Al (formed in alloys with a 14% Al content) was much greater than that of the γ solid solution (formed in alloys with 3% Al) due to the formation of spinel-like oxides on the surface. In two-phase alloys, the presence of the γ' phase made a major contribution to the over-all heat resistance. The introduction of Cr and Ti in addition to Al produced a further rise in heat resistance. (Metals Abstr.)

58225 THERMOPHYSICAL PROPERTIES OF YTTRIUM ABOVE 20^{0}C. Suganeev, Yu. S.; Taubin, M. L.; Yakutovich, M. V. Izv. Akad. Nauk SSSR, Metal.; No. 6, 215-17(Nov-Dec 1970). (In Russian).

The thermophysical properties of Y (thermal conductivity, thermal diffusivity, specific heat and electrical conductivity) were studied at 20 to 400°C. An empirical relationship was obtained for the specific heat at constant pressure: $294.3 + 1.59T - 3.3 \times 10^{-4}T$ J/kg°C, T being the absolute temperature. Both phonon and electron mechanisms made appreciable contributions to the thermal conductivity. The observed contribution of the phonon mechanism agreed in order of magnitude with the theoretical value. (Metals Abstr.)

58226 ADSORPTION OF OXYGEN ON THE BOUNDARIES (100) OF TUNGSTEN. Gorodetskii, D. A.; Mel'nik, Yu. P. (Kiev State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 5, 1064-9(May 1971). (In Russian).

The action of oxygen on the surface of tungsten was studied by two simultaneous methods: the diffraction of slow electrons, and the contact difference of potentials, which together yielded complete information on the O–W (100) system. The work function at the surface of W was determined as a function of the O adsorption time at room temperature. The change in the work function at the W surface with an O film present was measured during heating over the temperature range 20 to 1,000°C. (K.S.W.)

58227 EVAPORATION OF TUNGSTEN IN STRONG ELECTRIC FIELDS AS STIMULATED BY NITROGEN ADSORPTION. Mikhailovskii, I. M.; Sidorenko, N. N. (Physical-Technical Inst., Kharkov). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 3, 680-3(Sep 1971).

Translated from Fiz. Tverd. Tela; 13: No. 3, 824-8(Mar 1971).

A field-ion microscope has been used to examine the evaporation rate of tungsten in strong fields at partial nitrogen pressures of $10^{-6} - 10^{-2}$ torr. The stimulated evaporation was recorded from the rate of increase in radius at constant voltage. The lower evaporation threshold coincides with the field corresponding to field ionization of nitrogen (150 mV/cm), and the rate of stimulated evaporation increases by four to five orders of magnitude as the nitrogen pressure varies in the range 10^{-5} to 5×10^{-5} torr. A recombination mechanism is proposed for the stimulated evaporation. (auth)

58228 ADSORPTION AND DESORPTION OF YTTERBIUM ON CARBONIZED TUNGSTEN. Marinova, Ts. S.; Zubenko, Yu. V. (Leningrad State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 3, 635-6(Sep 1971).

Translated from Fiz. Tverd. Tela; 13: No. 3, 769-71(Mar 1971).

The effect of the adsorption of ytterbium on the work function and desorption of the metal on carbonized tungsten in the presence of an electrical field has been studied in the field-emission microscope. It is shown that carbonizing the tungsten has no effect on the electron-emission properties of the system Yb–W. The heat of desorption of ytterbium ions has been determined as $l_{0+} = (3.1 \pm 0.1)$ eV for $\theta = 1$. (auth)

58229 INITIAL PHASES IN THE CONDENSATION OF ZIRCONIUM ON TUNGSTEN AND THEIR CONNECTION WITH SURFACE MIGRATION. Golubev, O. L.; Odishariya, G. A.; Shrednik, V. N. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 3, 628-34(Sep 1971).

Translated from Fiz. Tverd. Tela; 13: No. 3, 761-8(Mar 1971).

The condensation of Zr on single-crystal W has been studied by means of the field emission microscope. The amount of Zr deposited did not exceed 0.2 of a monatomic layer. At tungsten temperatures T from 80 to 180°K, the Zr formed a relatively uniform deposit. At W temperatures from 210 to 300°K, isolated accumulations of Zr built up on the {112}, {123}, and {110} faces and in the vicinity of these faces. Intermediate structures were found at T = 180–210°K. Heating the condensate obtained at 80 to 300°K resulted in structures typical of condensation at 300°K. The accumulations referred to above were stable up to 410°K, but in the range 410 to 515°K they disappeared irreversibly, light edges being formed on the emission patterns in the vicinity of the faces mentioned. At $T \geq 515°K$ these edges also broke down irreversibly. A check test on "thicker" deposits at 300°K revealed the existence of accumulations of Zr on the $\{112\}$ and $\{123\}$ faces of W up to coverings of about 0.7–0.8 of a monatomic layer without any subsequent preferential growth of three-dimensional crystals in these regions. The accumulations of Zr on the $\{112\}$, $\{123\}$, and $\{110\}$ faces of W are interpreted as small two-dimensional islands which are formed at $T > 210°K$ as a result of the residual relaxation path of the adatoms. Ordinary thermal migration makes an ever-increasing contribution to their formation at higher temperatures. The disappearance of the accumulations and the further changes at 410–515°K and higher may be regarded as the result of the operation of two processes, viz., the irreversible transition from the initial nonequilibrium distribution of the adsorbate over the faces to an equilibrium distribution (which is still far from complete at ~515°K) and the reversible phase transformations: two-dimensional gas $\rightleftharpoons$ crystal. (auth)

58230 DESORPTION OF YTTERBIUM AND NEODYMIUM FROM TUNGSTEN BY AN ELECTRIC FIELD. **Ionov, N. I.; Marinova, Ts. S. (Leningrad State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 3, 557-63(Sep 1971).**

Translated from Fiz. Tverd. Tela; 13: No. 3, 674-81(Mar 1971).

Electron field emission was employed to determine the relationship between the temperature T of a tungsten filament, the degree of coverage θ of the (111) and (001) faces of the filament with ytterbium and neodymium atoms, and the electric field E_g required for the desorption of the latter from the filament. In every case the value of E_g increased and the work function $\varphi(\theta)$ diminished as θ increased from 0 to 1. In the case of Nd the minimum work function φ of the faces corresponded to the maximum value of E_g for $\theta = 1$. In the case of Yb no such extermal values of φ and E_g were observed. For $\theta \leq 1$ the $E_g(\theta)$ curves exhibited steps apparently due to rearrangements in the structure of the adsorbate. From the experimental $\sqrt{E_g} = f(T)$ relationships, the heats of desorption l_{0+} of the Yb^+ and Nd^+ ions were determined, together with the relative lifetimes τ_0/τ of the adsorbed atoms with respect to desorption in the form of ions for $\theta = 0.3$ and 1. The resultant values of l_{0+} depended weakly on the θ of the faces; for $\theta = 1$ the values were 3.2, 3.3, and 3.7 eV (Yb) and 3.7, 3.95, and 4.4 eV (Nd) for the (121), (111), and (001) face, respectively. The relative error in determining these quantities was estimated at 10%. The field factor β for all faces of the tungsten filament fell smoothly by 5–6% on passing from the boundaries of the faces to the center. (auth)

58231 EFFECT OF THE DEFORMATION TEMPERATURE ON THE STRUCTURE AND MECHANICAL PROPERTIES OF LOW-ALLOYED MOLYBDENUM. **Vitorskii, Ya. M.; Ivashchenko, R. K.; Kaverina, S. N.; (and others) (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved.; 31: No. 5, 1076-84 (May 1971). (In Russian).**

A low solubility of the majority of refractory metals in Mo seriously limits the possibility of modifying its properties. The role of structural characteristics and deformation in the formulation of the mechanical properties of Mo were investigated at various temperatures of deformation. Deformation at temperatures below 900°C resulted in anisotropy of the temperature of cold brittleness, and, as a consequence, ductility. Anisotropy of the temperature of cold brittleness is associated with a varied tendency of samples, cut out lengthwise and crosswise to the direction of rolling, toward stratification. (tr-auth)

58232 STUDY OF THE AGING OF TERNARY Fe–Ni–Mo AND QUATERNARY Fe–Ni–Co–Mo ALLOYS BY DILATOMETRY, ELECTRIC RESISTIVITY AND ELECTRON MICROSCOPY. **Servant, C.; Maeder, G.; Cizeron, G.; Lacombe, P. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France. Paris Univ.). Mem. Sci. Rev. Met.; 68: No. 4, 201-13(Apr 1971). (In French).**

The study of ternary 74.15%Fe–20.49%Ni–5.36%Mo and quaternary 67.49%Fe–18.65%Ni–8.99%Co–4.87%Mo (wt) alloys demonstrated that the kinetics of precipitation and austenite formation are correctly described by Johnson–Mehl type equations. Phenomena associated with the transition towards 450 to 480°C are currently under investigation. The electron diffraction diagrams obtained from the thin films considered allowed only a rough determination of the precipitates formed during aging to be made. Accurate determinations of the resistivities corresponding to the precipitation and austenite formation were made using Johnson–Mehl equations. (France)

58233 EFFECT OF HEATING BY GLOW DISCHARGE ON THE PHYSICO-CHEMICAL SURFACE CONDITION OF SOLID ALLOYS. **Samsonov, G. V.; Mukha, I. M.; Dovbishchuk, M. N.; Kal'nenko, B. I. Elektron. Obrab. Mater.; No. 5, 32-8(1970). (In Russian).**

The effect of ionic heating on the physicomechanical surface properties of solid alloys of the Type VK, VK2, VK6, VK8, VK15, and VK20 and TK, T5K10, T15K6, and T30K4 and tungsten and titanium carbides during diffusion welding in a glow discharge is demonstrated. An analysis is presented of the variation of the chemical composition of surface layers as a function of the energy condition and the electron structure of the heated materials. (JPRS)

58234 NEW TIN–TITANIUM ALLOY. **Guernsey, J. B.; Petersen, V. C.; Dulis, E. J. Tin Uses; No. 84, 10-11(1970).**

A Ti alloy containing 11.5% Mo–6%Zr–4.5%Sn and called Beta III is reported to have good ductility at room temperature. Properties are listed in comparison with other Ti alloys. (Metals Abstr.)

58235 EFFECTS OF COMPOSITION OF HARDFACING ALLOYS ON THEIR HARDNESS. **Khutoryanskii, E. D.; Demyantsevich, V. P. Svar. Proizv.; No. 9, 9-11(Sep 1970). (In Russian).**

Studies on the ternary systems Fe–Co–Mo and Fe–Co–W were carried out to determine the effects of the primary addition elements (Co, Mo, and W) and secondary additions (Mn, Ni, Cr, and Ti) on the hardness of dispersion-hardening alloys used for hardfacing. Regression analysis established that, following remelting, the hardness of the alloys decreased with increasing Ni, Mn, and Co, while increasing W, Cr, and especially, Ti have the opposite effect. Alloys, with HRC <35 after remelting were characterized by the highest Co contents (36.5%) and highest tempering temperature (700°C). (Metals Abstr.)

58236 MICROHARDNESS AND INTERNAL STRESSES OF ELECTROLYTIC NICKEL–TUNGSTEN ALLOYS. **Vas'ko, A. T.; Shaturskaya, V. P. Elektron. Obrab. Mater.; No. 4, 54-7(1970). (In Russian).**

The microhardness of a number of electrolytically-deposited Ni–W alloys was studied and correlated with the internal stresses as determined by x-ray diffraction. Heat treatment (or increasing the c.d. employed in the electrodeposition) increased the microhardness of the alloys. All factors increasing the proportion of W in the alloy (e.g., a corresponding change in the chemical composition of the original solutions) reduced the internal stresses owing to an analogous change in the energy state of the constituent atoms. The internal stresses were sensitive to the presence of H. (Metals Abstr.)

58237 VARIATION IN THE SOLUBILITY OF CERIUM, PRASEODYMIUM, AND NEODYMIUM IN CHROMIUM WITH TEMPERATURE. **Kobzenko, G. F.; Kholodov, A. G.; Ivanchenko, V. G.; Martynchuk, E. L.; Kashevskaya, O. N. Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 11, 1045-8(Nov 1970). (In Ukrainian).**

The solubility of Ce, Pr, and Nd in Cr was studied at 1000 to 1800°C by metallographic analysis, x-ray diffraction, and microhardness measurements. The limiting solubilities were 1.2, 0.9, and 1.1 at. %, respectively. The rare earth metals had an appreciable effect on the hardness of original material. On alloying Cr containing O with rare earth metals, two distinct deoxidation processes (primary and secondary) took place. The degree of Cr deoxidation was greater for the primary process. (Metals Abstr.)

58238 VISCOSITY, DENSITY, AND AUTODIFFUSION IN MOLTEN, EQUIATOMIC INDIUM–BISMUTH ALLOY. **Petrescu, N. Rev. Met. (Madrid); 6: No. 5, 501-8(Sep-Oct 1970). (In Spanish).**

The viscosity, density, and diffusivity of a high-purity 50:50 In–Bi alloy were studied over the range 110 to 220°C, under vacuum, using oscillating-crystal, dilatometric, and capillary deposit techniques with ^{114}In and ^{210}Bi as radioactive tracers. Viscosity/temperature and diffusivity/temperature relations show significant departures from linear near the solidification temperature. This is attributed to the formation of short-range-order complexes. The dissociation coefficient binding constant, and volume fraction of bonds were calculated. (Metals Abstr.)

58239 EFFECT OF ZIRCONIUM ADDITIONS ON THE CREEP STRENGTH OF ALUMINUM–COPPER ALLOYS. **Screm, G.; Palumbo, D. Alluminio; 39: No. 11, 583-9(1970). (In Italian).**

Two Al alloys containing Cu 6.01 and Ti 0.11% and Cu 6.10, Ti 0.10, and Zr 0.35%, were compared in a series of creep and stress-rupture tests at 150 to 250°C. These tests indicate that Zr has more effect on the 1000 hr stress rupture values than on

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elongation at rupture. Aging tests and electron-microscope studies supported the hypothesis that a grain-boundary blocking mechanism, caused by a Zr-rich grain-boundary precipitate, is responsible. (Metals Abstr.)

58240 ANISOTROPY OF SELF-DIFFUSION OF YTTRIUM. Gornyi, D. S.; Al'tovskii, R. M. Fiz. Metal. Metalloved.; 30: No. 1, 85-9(Jul 1970). (In Russian).

The self-diffusion coefficient of Y was studied in two mutually perpendicular crystallographic directions (along and across the c axis) at 900 to 1300°C. There was only a slight anisotropy of the diffusion characteristics, and this diminished with increasing temperature. The equations governing the diffusion coefficient were $D = 8.2 \times 10^{-1} \exp[-60{,}300/RT]$ and $5.2 \exp[-67{,}100/RT]$ cm^2/sec in the directions along and across the c axis, respectively. The anisotropy agreed with the value determined from independent data. (Metals Abstr.)

58241 TEMPERATURE RELAXATION IN METALS. Piterimov, V. A.; Mal'tseva, G. K. (Mordovia State Univ., Saransk, USSR). Fiz. Metal. Metalloved.; 30: No. 1, 175-80(Jul 1970). (In Russian).

Factors affecting the relaxation of vacancy concentration, interatomic distance, etc. in metallic crystals under the influence of a temperature field are discussed theoretically, with special reference to the frequency dependence of the temperature coefficient of electrical resistance in samples subjected to periodic changes of temperature. On the basis of this theory, a method of measuring the temperature coefficient of electrical resistance on the dynamic principle is proposed. An example of the use of this method in the case of W wires at 1400 to 2100°C is presented. For this material there is an anomalous change in the temperature coefficient of electrical resistance at 1700°C. (Metals Abstr.)

58242 COMPARISON OF STAINLESS STEEL AND ZIRCALOY-2 AS ENCAPSULATION MATERIALS FOR ^{252}Cf. Philbin, P. (Geological Survey, Washington, D. C.); Senftle, F.; Duffey, D.; Wiggins, P.; Evans, A. G. Nucl. Technol.; 12: No. 4, 404-6 (Dec 1971).

A comparison is made of the experimental neutron capture background from 3 MeV to 10 MeV of two ^{252}Cf neutron sources, one encapsulated in stainless steel and one in Zircaloy-2. The background of the Zircaloy-2 source was significantly lower than for the stainless steel source above 6 MeV because of the absence of the high energy capture gamma peaks due to iron, chromium and nickel. Below 5 MeV, the californium fission gamma-rays are the major source of interference. (auth)

58243 DATA ON ZIRCALOY CLADDING TUBES. Kobe Seiko Giho; 20: No. 2, 57-65(Apr 1970). (In Japanese).

Zircaloy-2 and -4 are used in nuclear reactors fueled by low-enrichment uranium dioxide and cooled and moderated with light water. Various properties of the alloys affect the design of a reactor and its fuel. Data collected on the properties of zirconium, Zircaloy-2 and -4, are presented in the form of figures and charts. Data are included on physical properties of zirconium, isotope ratio, thermal neutron absorption, and crystal structure. Data are also included on physical properties of Zircaloy-2 and -4, including density, thermal neutron absorption, thermal expansion, heat conductivity, Young's modulus, and Zr gas phases. Data on mechanical properties of Zircaloy-2 and -4, such as tensile property, creep characteristics and fatigue are presented. Corrosion properties of Zircaloy-2 and -4, including water corrosion, hydrogen absorption, solid solubility limit of hydrogen, and the relation of corrosion and oxide films are summarized. Irradiation effects, including the effects on mechanical properties and corrosion, are described. (Japan)

58244 SURFACE REACTIVITY AND BASIC ETCHING MECHANISM STUDIES ON GERMANIUM, ALUMINUM, AND URANIUM DIOXIDE. Ehamn, Michael Frederick. Philadelphia; Pennsylvania State Univ. (1970). 287p. University Microfilms Order No. 71-16,595.
Thesis.

A literature survey of the etchants and polishes for solid-state materials is presented which covers the literature from 1874 to 1970. Ellipsometric techniques were used to investigate the thin films that formed on cleaved germanium samples in air, deionized water, and 30% hydrogen peroxide. In all three cases the films were less than 100 Å in thickness. The films formed in air and water had a refractive index of 1.63 which is close to that of GeO_2. An increase of refractive index to about 1.74 was observed when the samples were immersed in a solution of 30% H_2O_2. The thickness of this film (~30Å) remained relatively constant in a period of 5 minutes to 6 hours. The film is attributed to a layer of $Ge(OH)_2^{2+}$ surface complexes, and a thick reaction envelope of metagermanic acid (H_2GeO_3). After rinsing surfaces covered with glassy GeO_2 with a 48% HF solution, the original oxide was removed; however, within 5 minutes a 30Å thick film of glassy GeO_2 had formed. Electron microprobe studies did not detect the presence of germanium monoxide. Studies on the effect of the concentration of the complexing agent in etching solutions showed that the etch rate is a function of the concentration when the concentration of the oxidizing agent is held constant. The {100} surfaces of germanium were etched in a solution of the basic composition $CPX : H_2O_2 : H_2O$ in the volume ratio 1 : 1 : 4 where CPX = tartaric, acetic, citric, oxalic, HCl, and HF acids, and mannitol. The variation in etch rates and activation energies with the complexing agent concentration indicated that the reactions are diffusion-controlled. A model is proposed for the crystal–solution interface which is consistent with the interdependence of the etch rates and the complexing ratio of the Ge. A comparison is made between optical and scanning electron microscopy techniques on germanium surfaces that have been etched in several common chemical etchants. The morphology of the etch pits due to dislocations and different types of surface preparation are discussed. The high resolution and depth of field of the scanning electron microscope allowed resolution of the fine structure of the etch figures. Single crystals of aluminum were etched under cavitation conditions in a 10% solution of sodium hydroxide. The cavitation processes prevented the buildup of oxide thin films, which under standard etching conditions would stop the etching processes. The etch rate of the aluminum at 60° was 0.460 $mg/cm^2/min$. The experimental activation energy determinations indicate that the rate-controlling step is diffusion with a value of $\Delta E_{act} = 3.9$ kcal/mole. A chemical etchant for UO_2 consisting of three parts concentrated HCl and one part concentrated HNO_3 was developed. This etchant, when used for ten minutes at 60°C on cleaved {111} surfaces, produced distinctive pits at dislocations intersecting the surfaces and at low-angle grain boundaries. The fact that the etch pits mark the sites of dislocations was shown by comparing the enlargement of pits with etching time and etch pits on matching cleavage faces. Comparison of etch rates at various temperatures gave an activation energy of 15.1 kcal/mole. (Diss. Abstr. Int., B)

58245 INFLUENCE OF THE NATURE OF A GRAPHITE LATTICE ON THE RATE OF IMPREGNATION BY MOLTEN ZIRCONIUM. Elyutin, V. P.; Kostikov, V. I.; Dergunova, V. S.; (and others). Tsvetn. Metal.; No. 4, 51-2(Apr 1971). (In Russian).

A porous graphite billet was machined into 20 × 60 mm cylinders which were heated, and then graphited with coke at 2000 to 2800°C. The samples thus prepared were submersed in liquid Zr at 1860, 2100, and 2250°C (5 to 20 sec). The data showed that at all temperatures the dependence of the impregnation rate on the interplanar distance in graphite was the same. The higher soaking temperatures lead to a decrease in the rate of impregnation. This temperature effect was explained by the formation of a Zr carbide on pore surfaces of the graphite. (K.S.W.)

58246 ADSORPTION AND DESORPTION OF RESIDUAL GASES ON A TUNGSTEN SURFACE IN A STRONG ELECTRIC FIELD. Suvorov, A. L.; Kukavadze, G. M. (Inst. of Theoretical and Experimental Physics, Moscow). Fiz. Metal. Metalloved.; 30: No. 1, 116-25(Jul 1970). (In Russian).

The adsorption of residual gas atoms and molecules on a W surface cleaned by evaporation in a strong electric field was studied using a field-ion microscope. Different crystallographic planes exhibited appreciably differing adsorption capacities, particularly in the early stages of the process. The manner in which the adsorbed atoms and molecules tended to arrange themselves on the W surface was clearly represented in the ion images obtained. On applying a strong electric field some of the adsorbed molecules underwent desorption, while others migrated over the surface. (Metals Abstr.).

58247 EFFECTS OF THERMAL CYCLING OF MONOCRYSTALS OF TUNGSTEN–MOLYBDENUM ALLOYS. Savitskii, E. M.; Burkhanov, G. S.; Tetyueva, T. V.; Kuz'mishchev, V. A. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR; 198: No. 2, 373-6(11 May 1971). (In Russian).

Thermal cycling of monocrystals of Mo–40% Nb in a helium atmosphere 20 times across the interval 1,600 to 400°C caused a decrease in unit dimensions in the monocrystal by a factor of ten, and an increase in the angular disorientation of the unit from 60 to 180′. The addition of as little as 5% of Re to either W or Mo increases their structural stability towards thermal cycling. Re is believed to lower the energy of formation of packing defects of W and Mo, and to increase their tendency to twin. (K.S.W.)

58248 MECHANICAL PROPERTIES OF MOLYBDENUM-BASE ALLOYS. Zhukova, E. G.; Kolikova, G. P.; Voronin, Yu.

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V. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met.; No. 72, 141-6(1970). (In Russian).

The effects of various W and Zr contents on the recrystallization temperature and mechanical properties of Mo were studied. Study was made of binary alloys of Mo–W containing W 2, 4, 6, 10, and 15%, and also ternary Mo–W–Zr (Zr 0.15% + W 2, 4, 6, 8, or 15%) sintered alloys. The alloys have good plastic deformation properties because they possess small grain sizes after sintering and high hardness (20 to 30 μm and HB ~ 150 kg/mm^2). Ternary alloys containing W 6-15% and Zr 0.15% had the highest recrystallization temperature, i.e. 1250°C Mo–W–Zr alloys, in the cold worked condition, had an UTS of 110 kg/mm^2 which is greater than that for the Zr-free alloys (75 kg/mm^2). Annealing at 1200°C causes a marked softening of all the alloys that is evidently associated with the recrystallization processes. (Metals Abstr.)

58249 NITROGEN SOLUBILITY IN METALS OF HIGH MELTING POINTS. **Jehn, H.; Hoerz, G.; Fromm, E. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Metall; 25: No. 7, 783-9(Jul 1971). (In German).**

Nitrogen solubility in high-melting metals such as vanadium, niobium, tantalum, chromium, molybdenum, and tungsten was examined. The results of studies of the nitrogen system in the VIa- and VIIα-metals within the ternary combinations (Nb–Mo–N, and Mo–W–N) are emphasized. Between the vanadium and the VIa group, a fundamental difference with respect to the nitrogen system is displayed, i.e., a continuous transition manifests itself between ternary and binary combinations. The reaction kinetics that establish equilibrium are briefly described. Also compiled are isobar nitrogen solubility, saturation concentration, and diffusion coefficients for binary nitrogen systems of metals with high melting points. (H.B.G.)

58250 ALLOYING OF MAGNICO ALLOY WITH NEODYMIUM. **Larina, L. S.; Chernov, V. M. Liteinoe Proizvod.; No. 1, 31-2 (Jan 1970). (In Russian).**

Magnico permanent-magnet alloys of the composition Co 23, Ni 13.5, Al 8.5, Cu 3, S 0.2, Ti 0.3%, remainder Fe, were prepared in high frequency induction furnace with additions of Nd 0.001, 0.002, 0.005, 0.05, 0.1, and 0.5%. The alloys were characterized by a dendritic structure, polishing capacity, and high magnetic properties. (Metals Abstr.)

58251 OXIDATION BEHAVIOUR OF NICKEL–VANADIUM ALLOYS IN AIR. **Kramer, K. H.; Borgstedt, H. U. Werkst. Korros.; 21: No. 10, 804-9(Oct 1970). (In German).**

When pure Ni is oxidized in air at 1000°C a simple NiO film is formed. When Ni–V alloys are oxidized, an outermost layer consisting mainly of Ni with a small $Ni(VO_3)_2$ content is produced. Below this is a second oxide layer with a high V content on the outside, and a low content of both metals on the inside. The innermost oxidation layer penetrates into the matrix as conic islands with concentrations of V_2O_3. The oxidation reactions obey parabolic laws for the formation of the outer NiO layers with Ni, and of NiO and $Ni(VO_3)_2$ with the Ni–V alloys. The activation energy of the oxidation is ~50 kcal/mole. (Metals Abstr.)

58252 HIGH-STRAIN-RATE DEFORMATION OF CADMIUM SINGLE CRYSTALS. **Schweighofer, Augustin; Polakovic, Anton. Kovove Mater.; 8: No. 4, 389-401(1970). (In Slovak).**

Dynamic behavior in compression at room temperature of Cd single crystals (99.999% purity) was investigated using a bar-type impulse test with a strain rate of 10^2/sec. Critical resolved shear stress measured at this rate was 9 times higher than that obtained at quasi-static test (strain rate ~10^{-3}/sec), but the hardening exponent remained practically unchanged. The deformation of Cd single crystals at the high strain rate (10^2/sec) was controlled by basal slip. (Metals Abstr.)

58253 HARDNESS OF ALLOYS IN THE MAGNESIUM–CADMIUM AND TELLURIUM–BISMUTH SYSTEMS. **Shishokin, V. P.; Bazilevskii, L. N. Tr. Leningrad. Politekh. Inst.; No. 305, 88-91(1970). (In Russian).**

Peculiarities in the hardness of some Mg–Cd and Te–Bi alloys are considered. In some of these alloys there is no linear dependence of the log indentation diameter (or log hardness number) on temperature. This is shown to be associated with the occurrence of supplementary physicochemical processes in these alloys. (Referativnyi Zh.)

58254 DOES THE OXIDATION OF ZIRCONIUM OBEY WAGNER'S THEORY? Lacombe, P.; Beranger, G.; Boisot, P.; Com-Nougue, J. Werkst. Korros.; 21: No. 12, 1010-15(Dec 1970).

The O diffusion in Zr follows a parabolic law from its initiation. Wagner's theory of diffusion in a homogeneous phase with the formation of an oxide layer has previously been found to be in good agreement with kinetics results for the steady state. However, the model cannot be directly applied to O diffusion in Zr and zirconia, and should be adapted to take into account the different atomic scale phenomena, especially the O diffusion in Zr. There is an initially disturbed oxidation period which implies a transitory state for the oxide growth. (Metals Abstr.)

58255 POWDER METALLURGICAL PRODUCTION OF NEUTRON-ABSORBER UNITS FOR NUCLEAR REACTORS FROM CHROMIUM–NICKEL STEEL WITH BORON CARBIDE BINDER AND ALSO FROM FERRO-BORON. **Spyra, Wolfgang; Gruenewald, Herbert. Dew Tech. Ber.; 10: No. 3, 270-3(Oct 1970). (In German).**

Porosity, B content, and pressure strength were determined for different sintering conditions and preliminary pressing conditions. Cr–Ni steels containing B 12.6 and 18% and ferro-B were sintered in the range 800 to 1100°C under high-purity H and under vacuum. Under specified manufacturing conditions it was possible to produce work-pieces fully complying with the desired value ranges for shape, porosity, B content, and compressive strength. (Metals Abstr.)

58256 STUDY OF THE ELECTROCHEMISTRY AND MORPHOLOGY OF ELECTRO-DEPOSITED NICKEL–MOLYBDENUM ALLOYS. **Hooper, R. A. E.; Gabe, D. R.; West, J. M. Trans. Inst. Metal Finish.; 48: No. 5, 182-90(1970).**

The most suitable solution for deposition of Ni–Mo alloys is one containing Na citrate, Ni sulfate, and Na molybdate buffered to pH 10.5 with ammonium hydroxide. The deposits consist of a fcc solid solution of Ni–17 at. % Mo. Structures and hardnesses of the deposits are reported and discussed in relation to their formation conditions. (Metals Abstr.)

58257 EFFECT OF CARBON AND ADDITION OF ELEMENTS BELONGING TO THE IRON GROUP ON MECHANICAL PROPERTIES OF MOLYBDENUM AND TUNGSTEN SINGLE CRYSTALS. **Kopecky, V.; Paschkowsky, A. I. Planseeber. Pulvermet.; 19: No. 1, 7-17(Mar 1971). (In German).**

The tensile strength, elastic limit, elongation, and reduction of area of zone-melted tungsten and molybdenum single crystals as a function of crystal orientation and test temperature were determined. The effect of carbon additions and, in the case of molybdenum, of iron-group metals, on these mechanical properties of the single crystals was also investigated. Large differences between the single crystals with ⟨100⟩- and ⟨110⟩-orientation were found, particularly with regard to the ductility. The hardening effect of carbon is probably due to the formation of substructures and grain refinement and a blocking of dislocations through carbide precipitates. In molybdenum with iron-group metal alloying additions, the interaction between the dislocations and interstitial alloying additions is weakened which generally improves the ductility, especially in the ⟨100⟩-crystals. (auth)

58258 MODIFICATION OF CAST ZIRCONIUM BY ADDITIONS OF TRANSITION METALS. **Samsonov, G. V.; Kashuk, V. A.; Filippov, B. F. (Kiev Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 2, 104-8(1971). (In Russian).**

The influence of small additions of the fourth period elements of the periodic system on the properties of cast Zr was investigated. Ten alloys of Zr were prepared from each of the following: Ti, V, Cr, Mn, Fe, Co, and Ni. Grain size, microhardness, and electric conductivity were measured and compared. The strongest modifying influence was revealed to be the metals of Group VIII. (K.S.W.)

58259 EFFECT OF NITRIDING ON THE PROPERTIES OF TANTALUM. **Kiparisov, S. S.; Levinskii, Yu. V.; Strogonov, Yu. D. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 2, 109-11(1971). (In Russian).**

The effects of temperature and time of nitriding of Ta on its tensile strength, relative elongation, and surface hardness were investigated. A temperature range of 1,000 to 1,400°C and nitriding times from 15 min to 6 hr were tested. The data showed that most satisfactory nitriding is accomplished at 1,100°C in one hour. (K.S.W.)

58260 ZONE LIQUATION IN NIOBIUM ALLOY INGOTS OBTAINED BY ELECTRONIC MELTING. **Suvorov, A. M. Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 2, 112-17(1971). (In Russian).**

The chemical composition of finished ingots and condensate was determined for Nb–W and Nb–Mo alloys which had different re-melting treatments. Fusion by a fixed electronic gun rotating at 3,000 rpm resulted in greater nonhomogeneity of alloy composition than in melting with rotational speeds of 30 rpm. The progress of reverse liquation in ingots is explained by the char-

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acter of solidification of the alloy, determined by its position in the phase diagram and by the thermal history of the ingot. (K.S.W.)

58261 PREFERRED POSITION OF TUNGSTEN CARBIDE IN THE COMPOSITION OF HARD METALS. Koelbl, F. (Metallwerk Plansee, Reutte, Austria). Planseeber. Pulvermet.; 19: No. 1, 18-24(Mar 1971). (In German).

In the production of hard metals, the carbides of tungsten, titanium, and tantalum are important as to hardness, whereby the tungsten monocarbide claims a preferred position. At least 98% of all hard metals contain WC as basic carbide, and perhaps 50% represent pure tungsten carbide—cobalt hard metals. Reasons for the preferred position of tungsten carbide are discussed with respect to physics, powder metallurgy, and sintering. An outstanding quality of tungsten carbide is its producibility in very wide ranges of grain size. In addition to pure tungsten carbide, the effect of other carbides on properties of hard metals is discussed. (H.B.G.)

58262 INFLUENCE OF ADDITIVES ON THE FORMATION OF PERIODIC PRECIPITATION (LIESEGANG BANDS) IN THE Ag–Cd SYSTEM. Shen, Y. S.; Zdanuk, E. J.; Krock, R. H. (P. R. Mallory and Co. Inc., Burlington, Mass.). Met. Trans.; 2: No. 10, 2839-44(Oct 1971).

Extensive regions of Liesegang bands, or periodic precipitation, are observed in composite materials prepared by the internal oxidation of Ag–9 Cd alloys containing small amounts of certain metallic elements: Al, Be, Mg, Sc, and Y. The elements which induce this form of distribution of oxide particles possess the following characteristics: relatively small atomic radius (less than 1.80 Å), high oxidation potential (higher than 1.66 V), and some solid solubility in silver at 800°C. In this solid-state system the constancy of the spacing coefficient, the ratio of distances from the surface of consecutive bands, is generally satisfied. The spacing coefficient is found to be dependent on a) the specific additive, b) the concentration of the additive, c) the concentration of the oxygen, and in some cases d) the crystal orientation. (auth)

58263 APPLICATION OF THE X-RAY SYNERGY METHOD TO ANALYSIS OF ROOM TEMPERATURE COMPRESSION OF BERYLLIUM CRYSTALS. Glass, H. L. (Autonetics, Anaheim, Calif.); Weissmann, S. Met. Trans.; 2: No. 10, 2865-74(Oct 1971).

A recently developed method (synergy method) was applied to zone-refined beryllium crystals compressed at room temperature. The synergy method, combining x-ray diffraction line profile analysis, x-ray topography, and metallography, is capable of analyzing lattice defects in small volume elements of the crystal (10-μ dia cross section by 5 mm in this case). Crystals oriented for basal slip, prism slip, and c-axis compression were examined. The existence of a columnar growth substructure was shown, which determined the response of the crystal to subsequent deformation. Inhomogeneous lattice rotation and basal plane bending induced by the interaction of basal slip dislocations with the columnar subgrain boundaries appeared to be a precursor of bend plane splitting. Crystals oriented for prism slip exhibited extensive twinning and those for c-axis compression gave rise to extensive basal slip. The predominance of basal slip in beryllium during room temperature deformation was found to be consistent with unique, anisotropic bonding characteristics. (auth)

58264 EFFECT OF DEFORMATION ON ThO_2 PARTICLE MORPHOLOGY IN W–1 WT. PERCENT ThO_2 MATERIALS. Dunham, T. E. (General Electric Co., Cleveland). Met. Trans.; 2: No. 10, 2797-2804(Oct 1971).

The distribution and deformation characteristics of ThO_2 particles during processing from powder to wire were investigated in a W–1 wt % ThO_2 material. The results indicate that larger thoria particles (>1 μm) deform concomitantly with the matrix to cigar-shaped particles and then fracture into segments as deformation of the matrix continues. Smaller particles remain relatively spherical and are not deformed. The net effect of this process is to superpose a nonuniform distribution of large particle segments on a background of small, undeformed, uniformly distributed particles. The consequences of this change in thoria dispersion morphology in reference to work hardening, recrystallization, and fracture of tungsten–thoria materials are discussed. In addition, some conclusions are drawn as to the origin of the large, deformable thoria particles and the effect of different processing modes on the resultant dispersion morphology. (auth)

58265 THERMODYNAMICS OF TITANIUM ALLOYS. II. THE Ti–Mo SYSTEM. Hoch, M.; Viswanathan, R. (Univ. of Cincinnati). Met. Trans.; 2: No. 10, 2765-7(Oct 1971).

The activity of titanium in Ti–Mo alloys containing from 30 to 100 at. % Ti was measured using the triple Knudsen cell technique. The binary system shows positive deviation from ideality. The regular solution parameter, Ω, which is independent of temperature and composition, was determined to be 2.9 ± 0.7 kcal per mol. This value agrees quite well with values calculated from the phase diagram, and with those obtained from theoretical calculations. (auth)

58266 DIFFUSION OF SUBSTRATE ATOMS INTO A SURFACE FILM AS INDICATED BY THE SECONDARY ION–ION EMISSION CHARACTERISTICS. Abramenkov, A. D.; Fogel, Ya. M.; Slezov, V. V.; Tanatarov, L.V.; Ledenev, O. P. Fiz. Metal. Metalloved.; 30: No. 6, 1310-12(Dec 1970). (In Russian).

The diffusion of Mo atoms into Ti and Cr films continuously deposited on a Mo substrate was studied by a method based on secondary ion–ion emission. The diffusion coefficient for the Mo/Ti and Mo/Cr systems was $D = 5.3 \times 10^{-3} \exp[-64{,}000/kT]$ and $D = 1.6 \times 10^{-2} \exp[-67{,}000/kt]$, respectively. The results agreed closely with independent data for the Mo/Cr system but systematic discrepancies occurred for Mo/Ti. Possible reasons are discussed. (Metals Abstr.)

58267 THERMAL DIFFUSION OF TRACES OF THALLIUM IN VARIOUS MOLTEN METALS. Kuz'menko, P. P.; Golovinskii, L. P. Fiz. Metal. Metalloved.; 30: No. 6, 1304-7(Dec 1970). (In Russian).

The thermal diffusion of Tl in molten Zn, In, Sn, Pb, and Bi was studied by a stationary method, using a system of capillaries in order to eliminate interference from convection. In all the metals except Bi, phonon drag constituted the major factor determining the motion of the impurity (moving towards the cold end). In the case of Bi the effects of thermal pressure predominated and the impurity moved towards the hot end. The results support existing theory. (Metals Abstr.)

58268 EFFECTS OF Mn, Si, Cr, AND Ni ON THE REACTION OF SOLUTION AND PRECIPITATION OF NIOBIUM NITRIDE IN IRON AUSTENITE. Koyama, Shinji; Ishii, Teruo; Narita, Kiichi (Central Research Lab., Kobe, Japan). J. Jap. Inst. Metals; 35: No. 7, 698-705(Jul 1971). (In Japanese).

The effects of manganese, silicon, chromium, and nickel on the solubility of niobium nitride in iron austenite have been studied by the method in which iron austenite was equilibrated with nitrogen gas. Manganese and chromium contained in iron austenite increase the solubility of NbN while silicon decreases the solubility of NbN. Nickel, in lower content, increases the solubility of NbN, but in much higher content, decreases it. The effects of those elements are more marked with decrease of temperature. Such changes are attributed to the effect of each element on the activity of niobium as well as that of nitrogen. Solubility product of NbN in iron austenite containing manganese, silicon, chromium, or nickel is described by the following experimental equation, respectively: $\log[\%\,\mathrm{Nb}][\%\,\mathrm{N}] = -8500/T + 2.89 + (1085/T - 0.68)[\%\,\mathrm{Mn}] - (48/T + 0.032)[\%\,\mathrm{Mn}]^2$, $\log[\%\,\mathrm{Nb}][\%\,\mathrm{N}] = -8500/T + 2.89 + (1900/T - 1.103)[\%\,\mathrm{Si}]$, $\log[\%\,\mathrm{Nb}][\%\,\mathrm{N}] = -8500/T + 2.89 + (1290/T - 0.77)[\%\,\mathrm{Cr}] - (51/T + 0.034)[\%\,\mathrm{Cr}]^2$, $\log[\%\,\mathrm{Nb}][\%\,\mathrm{N}] = -8500/T + 2.89 + (694/T - 0.44)[\%\,\mathrm{Ni}] - (29/T + 0.0178)[\%\,\mathrm{Ni}]^2$. (auth)

58269 EFFECTS OF GRAIN SIZE AND CARBON CONTENT ON THE DUCTILITY OF RECRYSTALLIZED MOLYBDENUM WIRE. Aritomi, Noriyoshi; Tsuya, Kazuo (National Research Inst. for Metals, Tokyo). J. Jap. Inst. Metals; 35: No. 7, 662-70(Jul 1971). (In Japanese).

To clarify the effects of both grain size and carbon content on the ductility of molybdenum, the variations in ductility with grain size were investigated on the three grades of 1 mm ϕ wire specimens by means of tensile tests at 25 and −76°C, respectively. These specimens differed in carbon contents as <10 ppM, 80 ppM, and 210 ppM. Oxygen and nitrogen contents were essentially of the same order for all of the specimens. It was found that specimens containing ≤10 ppM carbon were extremely low in ductility due to intergranular brittleness when the average grain diameter in the transverse cross section was larger than about 0.04 mm, though they showed high ductility when it was smaller than 0.04 mm. In the fine grained specimens, however, the effect of grain size, per se, was obscured because the recrystallized grains were greatly elongated in the direction of the specimen axis and because of an abnormal increase in yield stress. At −76°C, the ductility of specimens containing 80 ppM carbon increased with increasing grain size when the average grain diameter was larger than about 0.08 mm. In specimens containing 210 ppM carbon the ductility increased nearly linearly with increasing inverse square root of the average grain diameter. In these specimens, however, the size of grain boundary carbides and the distribution of carbides in matrices also varied with grain size. When the average grain diameter in transverse cross section was larger than about 0.04 mm, both of the specimens containing 80 and 210 ppM carbon were clearly more ductile than the specimens containing ≃10 ppM carbon; which indicates that a suitable amount of carbon suppresses the intergranular brittleness and increases the ductility. Since coarse carbides act as fracture initiation sites, the specimens containing 80 ppM carbon which were free from the intergranular brittleness but did not contain coarse carbides, were most ductile. When the average grain diameter in transverse cross section was smaller than about 0.04 mm, the ductility of the specimens containing ≃10 ppM carbon was as high as or higher than that of the specimens containing 210 ppM carbon. However, considering the uniaxed recrystallized structures in the former, it was not clear whether carbon increases or lowers the ductility in an equiaxed fine grained molybdenum. (auth)

58270 LEED STUDY OF THE ADHESION OF COPPER AND TUNGSTEN TO THE (111) SURFACE OF NICKEL. Buckley, Donald H. ASLE (Amer. Soc. Lubric. Eng.) Trans.; 13: No. 1, 39-45(Jan 1970).

Adhesion studies were conducted with Cu, W, and oxidized W contacting a Ni(111) surface. The Cu, W, and oxidized W were 1-mm dia flat-ended fibers which contacted the Ni surface at loads of 30 to 150 mg and surface contact times of 10 to 300 sec. The Ni(111) surface was examined before and after adhesion contact with LEED. With clean metals in adhesive contact, fracture in tension occurred in the lower cohesive strength material. When Cu contacted Ni, a surface alloy formed. The adhesion of clean Ni to an oxidized W surface resulted in O transfer from W to Ni with atomic surface rearrangement of the O. (Metals Abstr.)

Structure and Phase Studies

Refer also to abstracts 58389, 58942, and 58947.

58271 (CALT-767-P-3-19) OBSERVATION OF SLIP BANDS IN MOLYBDENUM SINGLE CRYSTALS BY X-RAY DIFFRACTION. Boyce, R. F.; Vreeland, T. Jr. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). [1968]. 7p. Dep. NTIS.

Berg–Barrett x-ray topographs of slip bands in Mo $\{124\}$ surfaces were compared with the electrolytic etch pit pattern. The darkened area corresponds in size and shape to the etch pitted area, indicating that the Berg–Barrett technique reveals the true extent of the slip band. (D.L.C.)

58272 THEORY OF PHASE TRANSITIONS IN THE β-TUNGSTEN STRUCTURE INDUCED BY THE BAND JAHN–TELLER EFFECT. Pytte, E. (IBM Watson Research Center, Yorktown Heights, N. Y.). Phys. Rev., B; 4: No. 4, 1094-1100 (15 Aug 1971).

A dynamic theory of the cubic-to-tetragonal transformation in the β-tungsten structure is presented starting with a Hamiltonian describing the interaction between static strain and acoustic phonons with the electrons in the triply degenerate d bands. For this model the elastic constants are strongly temperature dependent in the low-frequency limit. However, for frequencies in the neighborhood of the Debye frequency, they are nearly temperature independent. (auth)

58273 STUDY OF THE MOLYBDENUM–ZIRCONIUM–CARBON SYSTEM. Zakharov, A. M.; Novikov, I. I.; Parshikov, V. G. Izv. Akad. Nauk SSSR, Metal.; No. 6, 204-7(Nov-Dec 1970). (In Russian).

The Mo–Zr–C phase diagram was studied by microstructural analysis, x-ray diffraction, thermal analysis, and measurements of microhardness, with special reference to the Mo corner; isothermal sections were plotted at 1200 to 2100°C. Between these temperatures Mo_2C, a ZrC-base solid solution, and Mo_2Zr were in equilibrium with the Mo solid solution. The Mo–ZrC section was of a quasi-binary nature with a eutectic melting point at 2260°C. The solubility of ZrC in Mo fell slowly with rising temperature. (Metals Abstr.)

58274 ALLOYS OF YTTRIUM WITH DYSPROSIUM AND HOLMIUM. Markova, I. A.; Terekhova, V. F.; Savitskii, E. M. Izv. Akad. Nauk SSSR, Metal.; No. 6, 170-5(Nov-Dec 1970). (In Russian).

The phase diagrams of the Y–Dy–Ho and Dy–Ho systems were studied by microstructural analysis, x-ray diffraction, thermal analysis, and measurements of hardness and electrical resistance. Both systems constituted continuous series of solid solutions. The solubility characteristics of the binary system were exactly reflected in the corresponding characteristics of the ternary system. The manner in which the physical properties of the ternary system varied with composition agreed closely with the Kurnakov laws relating to binary systems. The ductility of the alloys makes them suitable for wire-drawing. (Metals Abstr.)

58275 INFLUENCE OF CRYSTAL LATTICE DEFECTS ON THE HIGH-ENERGY PROTON SHADOW EFFECT [IN MOLYBDENUM]. Ivanov, L. I.; Makhlin, N. A. Izv. Akad. Nauk SSSR, Metal.; No. 6, 154-7(Nov-Dec 1970). (In Russian).

The effect of dislocations introduced into Mo single crystals by plastic deformation on the proton diffraction patterns of the corresponding material, and in particular on the proton "shadow" effect, was studied and correlated with the existing data relating to other metals (Al, Au, etc.). The shadow effect was very sensitive to the presence of dislocations and the structure of dislocation networks. Possible ways of exploiting this relationship are considered. (Metals Abstr.)

58276 STRUCTURE OF GALLIUM–INDIUM ALLOYS IN THE MOLTEN STATE. Romanova, A. V.; Mel'nik, B. A. Izv. Akad. Nauk SSSR, Metal.; No. 6, 158-64(Nov-Dec 1970). (In Russian).

The structure of Ga–In alloys in the molten state was studied by x-ray diffraction. Both eutectic and other alloys exhibited a "quasi-eutectic" structure in the molten state with large micro-inhomogeneities of density. This effect appeared very strongly near the melting point but was also noticeable at 300°C above the liquidus. Loose regions of pure In and Ga also appeared in the melts. Raising the temperature gradually eliminated the quasi-eutectic structure as mutual dissolution set in. (Metals Abstr.)

58277 STRUCTURAL PECULIARITIES OF POLYCRYSTALLINE MOLYBDENUM HARDENING DURING EXTRUSION. Mochalov, G. A.; Evstyukhin, A. I. (Moscow Engineering-Physics Inst.). Fiz. Metal. Metalloved.; 31: No. 5, 1085-7(May 1971). (In Russian).

The possible reasons for unusual changes in molybdenum structure during hydroextrusion were experimentally investigated. In contrast to the usual methods of ductile reworking, a single-pass hydro-extrusion of molybdenum with a considerable amount of reduction resulted in a vortex structure with hair-like dimensions in the transverse direction. In the longitudinal direction the grain was very much elongated, forming a fibrous structure. (K.S.W.)

58278 DIRECT OBSERVATION OF FLUCTUATIONS OF DEUTERIUM DISTRIBUTION IN $(Nb_{0.33}Ti_{0.66})D_{0.33}$. Miron, N. F.; Shcherbak, V. I.; Fykin, L. E.; (and others). JETP Lett. (USSR) (Engl. Transl.); 13: No. 12, 485-7(20 Jun 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 12, 686-8(20 Jun 1971).

An x-ray-diffraction and neutron-diffraction study was made of $Nb_{0.33}Ti_{0.66}D_{0.33}$. The deuteride was found to retain the bcc arrangement of the initial alloy $Nb_{0.33}Ti_{0.66}$, indicating a solid solution of D in the alloy. The neutron diffraction patterns show, besides the bcc reflections, an intense diffuse maximum in the 2θ interval from 20 to 40°; this diffuse reflection is due to fluctuations of the distribution of the D atoms. (D.L.C.)

58279 STRUCTURE OF ANOMALOUSLY COARSE GRAINS IN SECONDARY RECRYSTALLIZATION OF TUNGSTEN FOILS. Zasimchuk, E. E.; Isaichev, V. I. (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved.; 30: No. 1, 189-92(Jul 1970). (In Russian).

The secondary recrystallization of a thin (50 μm) W foil vacuum-annealed at 1000 to 2300°C and then electropolished in KOH solution with a current density of 10 A/cm^2 was studied by optical microscopy and by an x-ray method using a two-crystal spectrometer. Anomalously large grains developed at 1800 to 2300°C; the structure of these was less perfect than that of the primary recrystallization grains, in opposition to existing data (Dunn and Koch, Acta Met., 5: 548(1957)). The reasons for this discrepancy are discussed. (Metals Abstr.)

58280 STRUCTURE OF DECOMPOSED Co–Nb ALLOY. Kokorin, V. V.; Tkachenko, O. E.; Chuistov, K. V. (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved.; 30: No. 1, 69-76(Jul 1970). (In Russian).

Structural changes taking place during the decomposition of the supersaturated solid solution in Co–4 wt % Nb alloys were studied by electron microscopy. Some structural inhomogeneities arising as a result of the decomposition of the high-temperature β-phase prevented the complete transformation of the latter into the α-phase. The stabilization of the β-phase was attributed to a dislocation mechanism involving a martensite-like phase transformation in Co. A simplified model of this mechanism is proposed. (Metals Abstr.)

58281 STRUCTURAL TRANSFORMATIONS IN COBALT–VANADIUM MELTS. Filippov, E. S.; Krestovnikov, A. N. Izv. Vyssh. Ucheb. Zaved., Chern. Met.; No. 9, 122-6(1970). (In Russian).

Structural transformations taking place in Co–V melts were studied by measuring the density, the geometric shape and size of the molten drops, and the relative light emission of various components. Plotted in the form of a conventional phase diagram, these results appeared to constitute the combination of a system of the eutectic type with a peritectic system. Some of the thermal effects observed were attributed to the vacancy mechanism governing the melting of the metals. (Metals Abstr.)

58282 RECRYSTALLIZATION AND CARBIDE PHASE FORMATION PROCESSES IN MOLYBDENUM BASE ALLOYS. Skakov, Yu. A.; Mezhennyi, Yu. O.; Zueva, I. B.; Spiridonov, V. B.; Selivanov, V. A. (Moscow Inst. of Steel and Alloys). Izv. Vyssh. Ucheb. Zaved., Chern. Met.; No. 3, 114-18(Mar 1971). (In Russian).

Using electron microscopy, microdiffraction, and x-ray methods, the structural features of two molybdenum alloys with various carbon contents were studied. In a low carbon alloy the state of the supersaturated solid solution is maintained after recrystallization annealing is carried to the point of embrittlement. Alloying with Re is not sufficient to cause embrittlement. The observed expansion of the grain boundaries in the brittle state is not connected with either localization of the carbide phase or with noticeable concentration enrichment of the boundary zones. (INIS)

58283 CONDITIONS FOR THE FORMATION OF OMEGA PHASE IN ALPHA + BETA TITANIUM ALLOYS. Dontsova, S. G. Tr. Irkutsk. Politekh. Inst.; No. 52, 34-44(1969). (In Russian).

The effects of alloying on ω phase formation in $\alpha + \beta$ Ti alloys was considered with particular reference to literature data on the effects of pressure. Using Ti–V alloys as an example, consideration was given to the influence of temperature on the difference in the specific volume of the α and β phases, and a formula was derived for calculating the probability of ω phase formation at various temperatures of the isothermal holding. The data on the temperature-dependence of the lattice constants of the β solid solution can be used to predict the heat-treatment conditions that will avoid embrittlement of Ti alloys by ω phase formation. (Referativnyi Zh.)

58284 INVESTIGATION OF FINE STRUCTURE PARAMETERS OF Al–W, Al–Mo, AND Al–Mn ALLOYS OBTAINED AT HIGH COOLING RATES. Burov, L. M.; Sheiko, T. I.; Bashev, V. F. (Dnepropetrovsk State Univ., USSR). Fiz. Metal. Metalloved.; 30: No. 1, 222-4(Jul 1970). (In Russian).

The structure of Al–W, Al–Mo, and Al–Mn alloys obtained by projecting drops of molten metal onto a rotating brass cylinder by means of a compressed air jet (achieving cooling rates of 10^7 °C/sec) was studied by x-ray diffraction. The sizes of the coherent-scattering region were determined in relation to the percentage of the second element in each case. For example, in pure Al a typical size was 1.3×10^{-5} cm, but on adding 2% of Mo or W this fell to 0.8×10^{-5} cm. The lattice constant changed analogously. (Metals Abstr.)

58285 RECRYSTALLIZATION OF COPPER REINFORCED WITH TUNGSTEN. Ozhigov, L. S.; Somov, A. I.; Chernyi, O. V. (Kharkov State Univ.). Fiz. Metal. Metalloved.; 30: No. 2, 447-8(Aug 1970). (In Russian).

The recrystallization of electron-beam-refined Cu reinforced with W wires 10 to 50 μm in dia was studied. The W occupied up to 25 vol.% of the whole samples. The W wires acted in the same way as dispersed particles of the same general size, in that they created local concentrations of lattice distortions which facilitated the formation of recrystallization centers and reduced the temperature corresponding to the onset of recrystallization by 80 to 100°C. (Metals Abstr.)

58286 CLASSIFICATION OF THE INDIUM–ZINC EUTECTIC. Nishimura, G. S. (Queen's Univ., Kingston, Ont.); Fidler, R. S.; Taylor, M. R.; Smith, R. W. Can. Met. Quart.; 8: No. 4, 319-22(Oct-Dec 1969).

The structure of the In–Zn eutectic was found to be broken lamellar, in agreement with calculated values of the solid-liquid interface roughness parameter. The conditions required to produce this structure are characterized. (auth) (Canada)

58287 TERNARY SYSTEM SILVER–INDIUM–ALUMINUM. Campbell, A. N.; Wagemann, R. (Univ. of Manitoba, Winnipeg). Can. J. Chem.; 48: No. 20, 3164-72(15 Oct 1970).

A number of alloys were examined microscopically. From these observations, from the equilibrium diagrams of the component binary systems, and from the application of the phase rule, a room temperature isothermal section was deduced. Three vertical sections through the ternary system were partially constructed from differential thermal analysis. These data show that invariant planes occur at 143, 148, 241, and 506°C. From the information obtained from the vertical sections and the room temperature isothermal section, isothermal sections were also proposed at 143 and 148°. The transformation at the 143°C invariant plane is a ternary eutectic, at 148° a ternary peritectic, and the other transformations at 241 and 506° are also ternary peritectics. Some evidence indicates that the ξ-phase of Ag–Al system and the γ-phase of Ag–In system link up through the ternary system forming a single phase region, and that such may also be the case with the phases μ and α' of the systems Ag–Al and Ag–In, respectively. The phases ϵ and ϕ of the system Ag–In do not appear to be capable of dissolving aluminum appreciably. (auth) (Canada)

58288 HEXAGONAL NETWORKS OF DISLOCATIONS IN α-ZIRCONIUM. Bedford, A. J.; Miller, D. R. (Univ. of Adelaide). J. Aust. Inst. Metals; 16: No. 3, 147-56(Sep 1971).

Several new mechanisms of formation of hexagonal networks of dislocations have been proposed to explain the observations of such networks in α-zirconium. The dislocations comprising the hexagonal networks all have Burgers vectors of the type $\langle 100 \rangle$ (or i.e., 1/3 $\langle 2\bar{1}\bar{1}0 \rangle$), but the networks are shown to be non-coplanar. Evidence is given to support the present proposals and to show that previously postulated mechanisms do not adequately explain the results of the present work. (auth)

58289 INFLUENCE OF YTTRIUM ON THE PHASE COMPOSITION OF VANADIUM–GALLIUM ALLOYS. Svechnikov, V. N.; Pan, V. M.; Spektor, A. Ts. (Inst. of Metallophysics, Kiev). Dokl. Akad. Nauk SSSR; 198: No. 2, 377-9(11 May 1971). (In Russian).

The portion of the ternary system V–Ga–Y bounded by the limits 47% Ga and 16% Y was investigated by preparing and testing 63 alloy samples. The solubility of Y in the compound V_3Ga was from 0.05 to 1%. α, β, γ, δ, and ϵ phases and their combinations are discussed. (K.S.W.)

58290 SYSTEM MOLYBDENUM–NICKEL–CARBON. Savitskii, E. M.; Zakharov, A. M.; Burkhanov, G. S.; Kataev, R. S. (Inst. of Metallurgy, Moscow). Izv. Vyssh. Ucheb. Zaved., Tsvet. Met.; No. 2, 91-4(1971). (In Russian).

The phase composition of alloys near the molybdenum corner of the Mo–Ni–C system was investigated, and the influence of nickel on the carbon solubility in Mo in the solid state was examined. The solidus temperature was obtained by differential thermal analysis, and with the use of a pyrometer. Isothermal profiles at 1800 and 1200°C were confirmed by microhardness and x-ray analysis. Adding Ni to Mo increases the solubility of C in the Mo; near 1800°C the solubility of C is raised from 0.04% to 0.07% by the introduction of 0.8% Ni. Adding Ni also noticeably lowers the solidus temperature of the Mo–C system and broadens the temperature interval of crystallization. (K.S.W.)

58291 NEW HIGH-TEMPERATURE PHASE OF PROTACTINIUM METAL. Asprey, L. B. (Los Alamos Scientific Lab., N. Mex.); Fowler, R. D.; Lindsay, J. D. G.; White, R. W.; Cunningham, B. B. Inorg. Nucl. Chem. Lett.; 7: No. 10, 977-80(Oct 1971).

On arc-melting a bead of very pure tetragonal Pa metal, using a water-cooled copper hearth, a new face-centered cubic structure with $\underline{a}_0$ = 5.02 Å was found, containing only a trace of the tetragonal phase. Flattening of the bead in a press resulted in reformation of the tetragonal phase, with only a small amount of the fcc form remaining. Re-examination of the x-ray photographs of a number of specimens taken earlier showed that some previously unexplained lines could have been due to this fcc phase. The metallic radius of the fcc form was 1.777 Å. (UK)

58292 CALCULATED LIQUIDUS AND SOLIDUS CURVES FOR THE Hf–Zr, Hf–U, AND Zr–U SYSTEMS. Chatterji, D. (Purdue Univ., Lafayette, Ind.). Met. Trans.; 2: No. 10, 2939-42(Oct 1971).

The solidus curves calculated from the published liquidus, using Steininger's approach, were compared with the published solidus curves for the Hf–Zr, Hf–U, and Zr–U systems. Excellent agreement was obtained for Hf–Zr and Hf–U, but not for Zr–U, indicating appreciable deviations from ideality. (D.L.C.)

58293 NATURE OF THE IMPURITY PHASE IN AN AGE-HARDENABLE Mg–10.8 WT. PERCENT Y ALLOY. Waldman, J.; Schwartz, M.; Perez, J. (Frankford Arsenal, Philadelphia). Met. Trans.; 2: No. 10, 2942-4(Oct 1971).

A study was made to identify the particles formed in Mg−Y alloys after solution heat treatment. Cast Mg−11 wt % Y plate was hot rolled and heat treated in the Mg-rich solid-solution phase field, and the Y content in the solid solution and particles was determined using an electron microprobe. The particles were identified as being Y_2O_3; this was confirmed by x-ray diffraction, and optical metallography was used to study the growth of Y_2O_3. It is concluded that when Mg−Y alloys are heated in air, oxidation to Y_2O_3 does occur below the surface. (D.L.C.)

Radiation Effects

Refer also to abstracts 57620, 58216, 58412, 59125, 59144, 59159, and 59160.

58294 (BAW-10006(Rev.2)) REACTOR VESSEL MATERIAL SURVEILLANCE PROGRAM. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Sep 1971. 34p.

A surveillance program to determine the effects of neutron irradiation on changes in the nil-ductility transition temperature of reactor vessel materials is discussed. Charpy and tensile specimens, which are machined from as-fabricated metal, heat-affected-zone metal (HAZ), and weld metal, are placed in six surveillance capsules containing dosimeters and temperature monitors. The capsules are then placed in three holder tubes, which are positioned so that the capsules are near the peak axial neutron flux. (In the first few plants of this class, two thermal-aging capsules have been located in an area of essentially zero flux.) The holder tubes are attached to the thermal shield and can be installed and removed along with the internals core support assembly. Once the internals are installed, the holder tubes are rotated toward the vessel's wall and locked in place at favorable locations for irradiation of the specimens. Calculation results indicate that B&W's method is a reliable, conservative means of predicting peak neutron fluence. (auth)

58295 (FRNC-TH-64) EFFECT OF NEUTRON IRRADIATION ON THE HIGH TEMPERATURE MECHANICAL PROPERTIES OF AN AGE-HARDENED 80-20 Ni–Cr ALLOY. Maissin, Jacques (Nancy Univ. (France). Faculte des Sciences). 30 Jan 1970. 74p. (In French). Dep. NTIS (U. S. Sales Only). Thesis.

Radiation effects on an 80−20 Ni Cr alloy hardened by precipitation of $Ni_3(Ti, Al)\gamma'$ particles were studied. After reviewing bibliographic data on high temperature rupture mechanisms and radiation induced intergranular brittleness, the tensile tests effected are described. The study of helium distribution after irradiation allowed the results obtained from tensile experiments to be used in the study of embrittlement mechanisms due to helium. The effects of the alloy structure and its deformation behavior before irradiation were studied. (auth) (France)

58296 (HEDL-SA-196) MECHANICAL PROPERTIES OF FAST REACTOR IRRADIATED AUSTENITIC STAINLESS STEEL WELDMENT MATERIALS. Ward, A. L.; Blackburn, L. D.; Lovell, A. J. (Hanford Engineering Development Lab., Richland, Wash.). [nd]. 5p. (CONF-711009-4). Dep. NTIS.

From Joint meeting of the American Nuclear Society; Miami, Fla. (17 Oct 1971).

Pre- and postirradiation mechanical property results have been obtained on specimens taken from weldments representing four weld processes and three filler metals: submerged-arc, Type 308; shielded metal-arc, 16-8-2 (Cr-Ni-Mo); gas tungsten-arc, Type 308; and gas metal-arc, Type 308L. All welds were made in one inch thick Type 304 plate and contained from 3 to 10 percent (by volume) δ-ferrite. No strong difference is noted in the rupture life behavior between Type 304 base metal and weld metal in general in either the irradiated or unirradiated conditions. While there are variations in degree among the various weld processes, there is a consistent trend toward reductions in rupture life due to irradiation. The primary contributor to losses in rupture life is reduced ductility since both the Type 304 base metal and the weld metal as a class showed no consistent tendency to increased creep rates. The submerged-arc and the gas metal-arc weldments showed smaller reductions in rupture life largely because small decreases in creep rate served to offset a portion of the ductility loss. On the other hand, the gas tungsten-arc and shielded metal-arc weld metal exhibited somewhat higher postirradiation creep rates which, coupled with reduced ductility, led to more substantial losses in rupture life. Reduction in creep ductility without significant changes in creep rate, along with sharply reduced tensile ductility with disproportionately small strength increases, suggest that the elevated temperature helium embrittlement process controlled ductility losses. (auth)

58297 (HEDL-TME-71-72) BIAXIAL STRESS RUPTURE PROPERTIES OF ANNEALED 316 STAINLESS STEEL AFTER EBR-II IRRADIATION. Barker, R. W.; Holmes, J. J. (Hanford Engineering Development Lab., Richland, Wash.). Aug 1971. Contract AT(45-1)-2170. 22p. Dep. NTIS.

The effects of EBR-II irradiation on the biaxial stress-rupture properties of mill-annealed Type 316 stainless steel were investigated at test temperatures of 1000, 1200 and 1400°F. Tubular cladding specimens having a 0.208 inch diameter and 0.008 inch wall were irradiated in Row 7 to a total fluence of 1.2×10^{22} n/cm^2 at an irradiation temperature of 1050°F ± 100. The composition of the tubing was as follows: 0.081 C, 2.3 Mo, 1.5 Mn, 13.2 Ni, 17.0 Cr and 0.5 Si. EBR-II irradiation produces a loss in rupture strength and ductility at all test temperatures and an increase in average creep rate at 1000°F. Stress-to-rupture values were reduced by about a factor of $^1/_{40}$ at a test temperature of 1000; at 1200°F a loss of about a factor of $^1/_2$ occurred. At 1400°F, the reduction in strength was highly stress dependent, but reductions as great as a factor of $^1/_{10}$ were observed. Creep strain was reduced as much as a factor of $^1/_{25}$, depending on test temperature and test duration. The greatest losses in ductility occurred at 1000 and 1400°F, with less effect occurring at 1200°F. The loss in stress-rupture life observed in this work was found to be a function of both ductility and creep rate modifications resulting from irradiation. At 1000°F, the reduced ductility and increased average creep rate control the rupture life. At intermediate temperatures little change in creep rate or ductility occurs; thus, rupture life is not greatly affected by irradiation. However, at 1400°F, reduced ductility (due to helium embrittlement without creep rate changes) again produces substantial losses in rupture life. (auth)

58298 (ORNL-TM-3493) EFFECTS OF STRUCTURAL IMPERFECTIONS ON VOIDS IN ALUMINUM. Farrell, K.; Houston, J. T.; Wolfenden, A.; King, R. T.; Jostsons, A. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 20p. (CONF-710601-12). Dep. NTIS.

From International conference on radiation-induced voids in metals; Albany, N. Y. (9 Jun 1971).

Impurities, inclusions, dislocations, and grain boundaries are structural features that significantly influence the nature and distribution of voids in neutron irradiated aluminum. Preinjected hydrogen and helium are shown to increase the nucleation of voids for a given fluence without changing the swelling, whereas substitutional-type impurities retard void nucleation. Accelerated void development is frequently noted in the immediate vicinity of inclusions, and in some cases large, spherical shells of voids form around inclusions. Alongside grain boundaries there are regions denuded of voids and next to these are regions in which void formation is enhanced; at low irradiation temperatures these near-grain boundary regions contain more voids than the grain interiors, but at high irradiation temperatures they contain very much larger voids than elsewhere. A microstructure consisting of many fine precipitates and dislocations has a much improved resistance to void formation. (auth)

58299 (ORNL-TM-3495) VOID FORMATION IN NEUTRON IRRADIATED METALS. Stiegler, J. O. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 60p. (CONF-710601-13). Dep. NTIS.

From International conference on radiation-induced voids in metals; Albany, N. Y. (9 Jun 1971).

The characteristics of void formation in high-purity metals are reviewed and summarized in terms of irradiation and material variables. Fluence, irradiation temperature, flux and spectral effects, and the role of impurities are discussed. Results are compared and contrasted with those for stainless steel and evaluated in terms of proposed mechanisms for the nucleation and growth of voids. Although general trends of behavior are established for most of the experimental variables, exceptions are invariably found. The observations indicate that details of the damage structure are purity- and structure-sensitive. (auth)

58300 (ORNL-TM-3496) EFFECT OF ALLOYING AND PURITY ON THE FORMATION AND ORDERING OF VOIDS IN BCC METALS. Wiffen, F. W. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 22p. (CONF-710601-11). Dep. NTIS.

From International conference on radiation-induced voids in metals; Albany, N. Y. (9 Jun 1971).

The void populations in Mo, Nb, V, and one alloy of each of these were compared by electron microscopy. All three of the systems responded differently to the alloying. The void concentrations and sizes in the Mo and Mo−0.5% Ti irradiated at 790°C were identical within the measurement limits. After irradiation at 585°C the Mo−0.5% Ti contained more voids than the Mo, but the sizes were nearly identical. Alloying Nb with 1% Zr reduced the void concen-

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tration after irradiation at 790°C by more than an order of magnitude, but this was compensated by an increase in void size. High void concentrations were observed in V irradiated at 385 to 600°C, but samples of V−20% Ti irradiated in the range 475 to 600°C had no detectable voids. The V−20% Ti contained high densities of irradiation-produced dislocations in networks and tangles. Voids in Mo, Mo−0.5% Ti, Nb, and Ta were ordered on a bcc superlattice parallel to the metal bcc lattice. Void ordering was not observable in the Nb−1% Zr or V. (auth)

58301 (RD/B/N-1971) ON THE LIMITATIONS OF THE METHOD OF LEAST SQUARES FOR THE TREATMENT OF CERTAIN TYPES OF DATA. Duckworth, F. C. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jul 1971. 16p. Dep. NTIS (U. S. Sales Only).

It is shown that the standard method of least squares is unsuitable for analyzing certain types of data, and particularly for data arising from the post-irradiation examination of fuel elements. It is suggested that a semi-subjective graphical technique may often give more useful results. (auth)

58302 MICROSTRUCTURAL ANALYSIS OF NEUTRON-IRRADIATED TITANIUM AND RHENIUM. Brimhall, J. L. (Battelle-Northwest, Richland, Wash.); Kulcinski, G. L.; Kissinger, H. E.; Mastel, B. Radiat. Eff.; 9: No. 3-4, 273-8(Jun 1971).

The defect structure in α-titanium and rhenium irradiated with neutrons at 0.4 T_m (T_m = absolute melting temperature) has been analyzed using transmission electron microscopy. In rhenium, the vacancies agglomerate into voids whereas in titanium, vacancy dislocation loops lying on the prism planes are the only vacancy-type defects observed. In both metals, dislocation segments and network fragments are the main evidence of interstitial-type defects. The presence of dislocation loops rather than voids in titanium irradiated at this temperature is an anomalous result when compared to results on other similarly irradiated pure metals. Possible explanations for the preferential formation of loops rather than voids in the titanium are discussed. (auth)

58303 EFFECT OF IMPURITIES WITH A NEGATIVE SIZE EFFECT ON THE RECOVERY OF ALUMINUM IRRADIATED WITH FAST NEUTRONS AT 78°K. Dimitrov, C.; Moreau, F.; Dimitrov, O. (Centre National de la Recherche Scientifique, Vitry-sur-Seine, France). Compt. Rend., Ser. C; 273: No. 1, 1-4(5 Jul 1971). (In French).

The presence of low amounts of chromium, copper, or vanadium in irradiated aluminum increased the stage III recovery. This behavior was in good agreement with the model of elastic interactions between impurities and the radioinduced interstitial defects. The effects of titanium additions were not explained by this model. (auth)

58304 VOIDS FORMED BY IRRADIATION OF REACTOR MATERIALS. Proceedings of the British Nuclear Energy Society, European Conference Held at Reading, England, March 24–25, 1971. Pugh, S. F.; Loretto, M. H.; Norris, D. I. R. (eds.). London; British Nuclear Energy Society (1971). 365p. £7.50. (CONF-710330).

Thirty-three papers are included which covered various topics relating to void production by fast neutrons, quenching, ion bombardment, high-voltage electron microscopy; theory of void formation; and nucleation of voids. A separate abstract was prepared for each paper. (D.L.C.)

For abstracts of individual papers see: 58305–58336 and 59145.

58305 FAST NEUTRON INDUCED VOIDAGE IN NON-FISSILE METALS AND ALLOYS: A REVIEW. Bagley, K. Q.; Bramman, J. I.; Cawthorne, C. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 1-26 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

The discovery of prolific void formation in stainless steels under fast neutron irradiation was first reported in 1966 and was quickly followed by accounts of its appearance in other metals and alloys. Recognition of the implications of the phenomenon on fast reactor design and operation have led to intensive research in many countries into the nature of void nucleation and growth processes and the magnitude of consequent dimensional changes in potential fast reactor cladding and structural materials. In this work, reliance was placed principally on transmission electron microscopy for the study of void incidence and morphology, on immersion density and linear dimensional measurements for the evaluation of macroscopic effects. Volume changes in excess of 5% were recorded in stainless steels, which by virtue of their great technological interest attracted most attention. In addition, work was published on the generation of voids in nickel, iron, aluminium, molybdenum, tungsten, vanadium, zirconium, titanium, rhenium, and copper. Data on the influence of such factors as neutron fluence, irradiation temperature, compositional and structural variables on void development and stability are reviewed. (auth)

58306 DENSITY CHANGES IN CLADDING MATERIALS IRRADIATED IN DFR. Bramman, J. I.; Bagley, K. Q.; Cawthorne, C.; Fulton, E. J.; Sinclair, W. D. J. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 27-33 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Density changes in four stainless steels (AISI M316 and M316L, FV548 and EN58B) and in a Nimonic alloy (PE16), due to voidage induced by fast neutron irradiation to fluences up to 8.7×10^{22} n. cm^{-2} in the temperature range 300 to 650°C, were shown to be very sensitive to small differences in composition and pre-irradiation condition. It was found that the data for a given material, condition, and irradiation temperature can be adequately represented by assuming a linear change in density with increasing displacement dose after a threshold. The work described shows that each material has a characteristic temperature dependence of swelling, though this is not susceptible to expression in analytical form. (auth)

58307 ELECTRON MICROSCOPE OBSERVATIONS OF VOIDS IN CLADDING MATERIALS IRRADIATED IN DFR. Cawthorne, C.; Fulton, E. J.; Bramman, J. I.; Linekar, G. A. B.; Sharpe, R. M. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 35-43 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Transmission electron microscopy was used in studies of void formation in a variety of cladding materials (M316, M316L, and FV548 stainless steels and Nimonic PE16) irradiated to fluences of up to $8.7 \times 10^{22} n.cm^{-2}$ in DFR, permitting the effects of fluence and irradiation temperature on void size and number density to be investigated. There are striking differences in the annealing behavior of various types of void population. (auth)

58308 EFFECT OF STRESS DURING IRRADIATION ON VOID FORMATION IN NICKEL. Barton, P. J.; Nutter, P. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 45-9 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

An experiment is described which is aimed to investigate the dependence upon uniaxial tensile stress of void formation in neutron-irradiated nickel. Irradiations were carried out to a dose of $3.6 \times 10^{24} n.m^{-2}$(fission) at 500°C and at stresses of 0.23, 5.38, and 17.24 MN m^{-2}. Although only preliminary structural data are available, it may be concluded that over this range of values void size is independent of stress and that void concentration is not markedly stress-sensitive. (auth) (UK)

58309 SOME ELECTRON MICROSCOPE OBSERVATIONS ON VOIDS IN VANADIUM, NIOBIUM, AND MOLYBDENUM. Elen, J. D. (Reactor Centrum Nederland, Petten, Netherlands). pp 51-62 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Samples of pure vanadium, niobium, and molybdenum were irradiated at three temperatures in the High Flux Reactor. Fast neutron fluences were $2.2 \times 10^{20} n/cm^2$ to $5.5 \times 10^{20} n/cm^2$ and temperatures covered the range of 0.25 T_m to 0.47 T_m. Some vanadium−2.8% titanium alloy samples were included. In all samples of the pure metals, voids were observed. Their size increased with irradiation temperature from 25 Å at 0.25 T_m to about 120 Å at 0.47 T_m. The logarithmic plot of the void densities, combined for the three metals, was found to decrease linearly with T/T_m over the range of $5 \times 10^{16}/cm^3$ to $1 \times 10^{14}/cm^3$. The thermal stability of the voids, produced at the lower irradiation temperature, was studied by 1-hr isochronal annealing series. Up to 0.45 T_m, larger voids grew at the expense of smaller ones, followed by rapid disappearance. Only a few voids were observed in the alloy. This is discussed in terms of dislocation damage distribution. (auth)

58310 FAST NEUTRON IRRADIATION OF Al, Mg, AND Cu. Levy, V.; Mathie, J.; Risbet, A.; Levy, R.; Poirier, J. P.

(CEN, Saclay, France). pp 63-9 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Results on void formation in Al, Mg, and Cu under fast-neutron irradiation are presented. The effects of different parameters were investigated e.g., temperature, dose, cold work, and impurity effects. (auth)

58311 EFFECT OF NEUTRON DOSE ON VOID FORMATION IN HIGH PURITY ALUMINUM. Packan, N. H. (IMF, Karlsruhe, Ger.). pp 71-8 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Transmission electron microscopy was used to investigate the fluence and flux dependence of void formation in pure aluminum. Voids observed resulted from neutron exposures ranging from 1.5×10^{19} to 1.6×10^{22} neutrons/cm^2 ($E > 0.1$ MeV), at a common irradiation temperature of 55 ± 5°C (0.35 T_m). By 10^{22} neutrons/cm^2, the voids ranged up to 1000 Å in diameter and comprised a total volume fraction of 7.4%. The mean void size was found to increase in proportion to the irradiation time raised to the one-sixth power. The void concentration increased rapidly at first but eventually approached saturation; expressed as a power relation, $N \sim (\phi t)^a$, the exponent decreased from 2.0 initially to 0.1 at the highest fluence studied. The void volume fraction was also found proportional to the fluence raised to a variable power, the value decreasing from roughly $5/2$ to $1/2$ over this range of fluence. These observations are compared with several current models for void formation. Irradiation at an order-of-magnitude lower flux resulted in changes in the void morphology (e.g., half as many, but larger and more frequently elongated voids) much like those resulting from irradiation at a higher temperature. Either case results in a lower in-reactor vacancy supersaturation, which in turn could be the cause of the void morphology changes. No difference in the void population was evident in material degassed prior to irradiation, when compared with similarly irradiated as-received material (containing 15 to 20 atomic ppM hydrogen). (auth)

58312 THEORY OF VOID GROWTH IN IRRADIATED MATERIALS. Bullough, R.; Perrin, R. C. (Atomic Energy Research Establishment, Harwell, Eng.). pp 79-107 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

The theory of void growth in irradiated materials is reviewed and correlated, where appropriate, to the available accelerator measurements in nickel and steel. The dependence of the void growth on the various physical parameters is emphasized; these include dose, dose rate, void density, dislocation density, precipitate (coherent and incoherent) density, and temperature. The various ways in which the swelling problem can be alleviated are discussed. (auth)

58313 VOID LATTICE IN MOLYBDENUM. Malen, K.; Bullough, R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 109-19 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

A theoretical explanation for the recently observed void lattice in molybdenum is presented. The void lattice is observed to be precisely parallel to the underlying molybdenum atomic lattice and therefore it is conjectured that its existence must be a direct consequence of the elastic cubic anisotropy of the molybdenum matrix. Using the theory of anisotropic elasticity, a noncentral pairwise void–void interaction energy is deduced in terms of various invariant derivatives of the appropriate Green's tensor and used to discuss the energy and equilibrium spacing of the void lattice. (auth)

58314 TEMPERATURE RANGE AND DOSE DEPENDENCE FOR VOID GROWTH IN IRRADIATED MATERIALS. Foreman, A. J. E. (Atomic Energy Research Establishment, Harwell, Eng.). pp 121-32 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

The rate of growth of voids during irradiation was determined from a calculation of the small disparity between the rates of diffusion of the interstitial atoms and vacancies to the voids. The driving force is taken to be the slightly preferential trapping of the interstitial atoms at dislocations, as suggested by Greenwood, Foreman and Rimmer (1959). The continually changing nature of the dislocation structure during an irradiation is represented by the continuum sink model. The temperature range for void growth can be understood in terms of a "phase diagram" showing the region of void growth as a function of temperature and sink density. The peak swelling in this range was calculated for constant dislocation densities and for a steadily increasing dislocation density (loop growth). The effect of a zone denuded of dislocations close to the void surface was also considered. The predicted dose dependence of the swelling is affected by the relative densities of the voids, dislocations, and precipitate particles, and lies in the range $(\text{dose})^{1.0}$ to $(\text{dose})^{2.0}$ in many cases. It is shown that the preferential trapping of interstitial atoms at the void surface would produce unusual void shrinkage effects, which could affect the void nucleation stage. (auth)

58315 INTERACTION BETWEEN A VOID AND A DISLOCATION LOOP. Willis, J. R.; Bullough, R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 133-47 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

The interaction between a pure edge dislocation loop and a spherical void was calculated and used to discuss the modes of glide and climb that can lead to dislocation depletion in the vicinity of the void. (auth)

58316 THEORETICAL MODEL FOR VOID FORMATION IN THE HIGH VOLTAGE MICROSCOPE. Fisher, S. B.; Williams, K. R. (Central Electricity Generating Board, Berkeley, Eng.). pp 149-57 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Observations made of the changing microstructure during void growth in the HVEM have led to the proposition of a simple theoretical model to describe the growth. Void formation is shown to be dominated by the increase in interstitial sink density as a result of interstitial loop growth under irradiation. This causes a time-dependent decrease in interstitial concentration and a corresponding increase in vacancy concentration. On impingement of the dislocation loops, mutual annihilation results in a loss of interstitial sink density at a rate dependent on dislocation movement and hence beam flux. It is this latter effect which results in a limitation to the void growth rate in annealed material. The difficulties in extending the theory to the case of neutron irradiation are discussed, and methods for swelling limitation arising from the model are examined in some detail. (auth)

58317 FORMATION AND BEHAVIOUR OF QUENCHED-IN VOIDS IN CLOSE PACKED METALS. Smallman, R. E.; Westmacott, K. H. (Univ. of Birmingham, Eng.). pp 159-76 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

The observation of voids produced in fcc and hcp metals by quenching is discussed and attention drawn to the role of impurity atoms, particularly hydrogen, in the nucleation process. The behavior of voids on annealing is also considered and a comparison made between voids and cavities containing gas. (auth)

58318 VOIDS IN THE INTERMETALLIC COMPOUND NiAl. Fraser, H. L. (Univ. of Birmingham, Eng.); Loretto, M. H.; Smallman, R. E.; Wasilewski, R. J. pp 177-82 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Large single crystals of nominally stoichiometric NiAl were sectioned and examined using transmission electron microscopy. Large voids up to 1100 Å in diameter were observed and it was shown that the faces of these voids are $\{110\}$ and $\{100\}$ planes. Measurements carried out on symmetrical voids have shown that the ratio of surface energies of the $\{100\}$ planes and $\{110\}$ planes is given by $\gamma 100/\gamma 110 = 1.10$. Annealing experiments carried out on bulk specimens result in the formation of voids elongated along $\langle 100 \rangle$ directions as well as voids which are symmetrical. The significance of these results is discussed in terms of the mobility of the high concentration of thermal vacancies in NiAl. (auth)

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58319 FORMATION OF VOIDS BY QUENCHING OR DEFORMATION OF METALS. Erich, Ruedl (CCR–EURATOM, Ispra, Italy). pp 183-90 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Earlier studies of voids in quenched platinum are discussed and more recent work on voids in deformed aluminum containing alumina particles described. Polygonal voids of diameters up to several hundred Å, produced by the aggregation of frozen-in vacancies, were observed in quenched Pt foils. The voids disappeared on annealing at 800°C. The voids were possibly stabilized by dissolved gas. Lenticular voids formed by interface failure, were observed at particles in deformed Al foils. With continued straining, the voids elongated in the direction of the tensile axis and occasionally were pinched off in regions of highly localized deformation. Preliminary annealing studies indicated that the voids change neither shape nor size on annealing at 400°C for $\frac{1}{2}$ hr. (auth)

58320 VOID FORMATION DURING ION IRRADIATION OF METALS AT ELEVATED TEMPERATURES. Nelson, R. S.; Mazey, D. J.; Hudson, J. A. (Atomic Energy Research Establishment, Harwell, Eng.). pp 191-203 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

The technique of simulating fast-neutron damage in metals by ion bombardment is discussed. The conditions necessary for obtaining quantitative design data are reviewed together with an outline of more qualitative experiments designed to elucidate the fundamental processes. A selection of results is presented to illustrate the usefulness of the technique. (auth)

58321 TEMPERATURE DEPENDENCE OF VOID SWELLING IN TYPE 316 AUSTENITIC STAINLESS STEEL IRRADIATED WITH 20 MeV C^{++} IONS. Williams, T. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 205-12 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Foils of Type 316 stainless steel containing 10^{-5} helium were irradiated to a dose of 3×10^{17} ions/cm^2 at temperatures in the range 400 to 700°C using 20-MeV C^{++} ions from the Harwell Variable Energy Cyclotron. This ion dose produced an estimated maximum of 40 displacements/atom at 6.6 μm below the ion-incident surface. The void volume at each temperature was determined by transmission electron microscopy. In solution-treated Type 316 steel, the void swelling reached a maximum of 12% at 600°C for a dose of 40 displacements/atom. In 20% cold worked Type 316 steel irradiated to the same dose, the highest swelling (9.5%) was at the highest temperature employed. (auth)

58322 VOID FORMATION IN NICKEL, 316 STEEL, AND NIMONIC PE16 DURING 20 MeV C^{++} IRRADIATION. Hudson, J. A.; Mazey, D. J.; Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). pp 213-21 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Nickel, 316 stainless steel, and Nimonic PE 16 foils containing 10^{-5} He, were bombarded at 525°C by 20-MeV C^{++} ions in the Harwell Variable Energy Cyclotron. Void swelling was determined by transmission electron microscopy for damage doses up to 400 d/atom in nickel and steel and 280 d/atom in PE 16. Dislocation density and other features were also investigated together with the effect of prior cold-work (20%) in 316 steel. Swelling in nickel varies as a linear function of dose up to 6% at 40 d/atom. The swelling rate then falls to give 15% swelling at 350 d/atom. In 316 steel, voids and dislocation loops are first observed at about 2 d/atom after which the swelling varies approximately as $(\text{dose})^2$. At 40 to 50 d/atom, the swelling rate decreases and the swelling versus dose curve merges with that for nickel. Void nucleation in nickel occurs at an early stage and swelling is predominantly by void growth. However, in 316 steel up to about 20 d/atom, the increase in swelling is due to an increase in both void size and void concentration; above 20 d/atom, void growth and coalescence dominate the kinetics. In general, swelling in PE 16 is much less than in nickel or steel, possibly due to enhanced recombination and the interaction of the radiation-induced dislocation structure with the coherent γ' precipitates within the matrix. (auth)

58323 TEMPERATURE DEPENDENCE OF VOID SWELLING IN 18/8/Ti STEEL. Walters, G. P. (Atomic Energy Research Establishment, Harwell, Eng.). pp 223-30 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

The Harwell Variable Energy Cyclotron was used to produce voidage in solution treated and 20% cold worked 18/8/Ti steel in the temperature range 450 to 700°C. All specimens were initially bombarded with α particles at ambient temperature to introduce a uniform concentration of helium (10^{-5} atoms/atom) throughout. This was followed by irradiating with 20-MeV carbon ions at 450, 525, 550, 600, 650, and 700°C to a constant dose of 4.5×10^{17} ions/cm^2 (60 displacements/atom in the peak damage region). Swelling was calculated from void counts taken from electron micrographs. Swelling in both the solution-treated and 20% cold-worked condition was markedly temperature-dependent, the dependency being less for the cold-worked steel. Cold working produced a beneficial effect at all temperatures up to 650°C; however, at 700°C the swelling was similar to the solution treated steel. (auth)

58324 EFFECT OF COLD WORK ON THE SWELLING OF TYPE 316 STEEL IRRADIATED WITH 20 MeV CARBON IONS AT 525^{0}C. Walters, G. P. (Atomic Energy Research Establishment, Harwell, Eng.). pp 231-37 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Since it had been shown that cold working can reduce the swelling of neutron-irradiated stainless steel, experiments using the Harwell Variable Energy Cyclotron were carried out to doses higher than those previously examined. Solution treated, 10%, 20%, and 40% cold-worked specimens containing 10^{-5} atoms/atom of helium were irradiated with 20-MeV carbon ions at 525°C to a dose of 3×10^{17} ions/cm^2 (40 displacements/atom in the peak damage region) or 1.5×10^{18} ions/cm^2 (200 displacements/atom). Electron microscopy showed that swelling at the lower dose was reduced slightly at all levels of cold work. However, at the higher dose only 40% cold work appeared to produce any significant reduction. It is considered that at doses not much greater than 200 displacements/atom, cold working (up to 40%) will cease to be beneficial. (auth)

58325 PRODUCTION OF VOIDS IN COBALT DURING ION BOMBARDMENT AND ELECTRON IRRADIATION. Manthorpe, S. A.; Buckley, S. N. (Atomic Energy Research Establishment, Harwell, Eng.). pp 239-46 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

A study was made of voids generated in the hcp and fcc phases of cobalt during 100-kV carbon-ion bombardment and electron irradiation in a 1-MV electron microscope. The results are incompatible with the dislocation preference hypothesis and were explained by a new model of void growth based on the differential velocity of vacancy and interstitial diffusion to glissile dislocations. (auth)

58326 SIMULATION OF FAST REACTOR IRRADIATION EFFECTS IN THE HIGH VOLTAGE ELECTRON MICROSCOPE. Norris, D. I. R. (Berkeley Nuclear Labs., Eng.). pp 247-68 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

A review is given of the basic characteristics of void growth in metals irradiated by the electron beam of a high-voltage electron microscope. This technique for simulating fast reactor effects has the advantage of permitting observations during irradiation. The relative simplicity of electron irradiation is valuable for void nucleation experiments. In nickel, it is found that implanted gas concentration is a controlling factor. Direct experimental evidence was obtained for dislocations acting as preferential sinks for interstitials, so promoting void growth. With increasing irradiation temperature, the void concentration decreases and the void size increases. The upper part of the temperature range for void growth is inaccessible because of surface effects. Void concentrations are reduced near surfaces and incoherent boundaries. The technique can be used quantitatively to determine the dose dependence of void swelling. In nickel, three stages are distinguished and are correlated with the development of the irradiation-induced dislocation structure. The observed swelling rates suggest that collision cascades are not important in void growth. (auth)

58327 PRODUCTION OF VOIDS IN COPPER BY ELECTRON IRRADIATION IN A 1 MV ELECTRON MICROSCOPE. Makin, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). pp 269-74 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Experiments were made on the formation of voids in copper during electron irradiation in a 1-MV electron microscope. The results described include the effects of dose, temperature, inert gas injection, alloying, temperature increases, annealing, gas bubbles, and neutron-produced voids. A model of void growth in high dose rate conditions is described in which voids grow as a result of the difference between the preference of interstitials for dislocations and voids. The void preference was demonstrated experimentally. Using the model it is shown that fairly accurate predictions can be made of the rate of swelling in given conditions provided the dislocation and void densities are known. (auth)

58328 GROWTH OF INTERSTITIAL AND VACANCY AGGLOMERATES IN NICKEL DURING ELECTRON IRRADIATION. Urban, K. (Max-Planck-Institut fuer Metallforschung, Stuttgart). pp 275-82 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Results are presented of investigations of the growth of defect agglomerates in nickel during electron irradiation at high temperatures in a Hitachi high-voltage electron microscope. In high-purity samples, the formation of interstitial dislocation loops was observed during irradiation at temperatures between 20 and 550°C. In an intermediate temperature region from about 200 up to 420°C, vacancy dislocation loops were also observed. The interaction of both types of loops provides clear evidence that in the stress field of edge dislocations, Frenkel defects are separated and that at edge dislocations interstitials are absorbed preferentially. Such preferential absorption is shown to be necessary for void growth. Voids only grew in samples containing impurities. The formation of voids was observed during irradiation at temperatures from 280 up to about 600°C. They annealed out completely at 730°C within 3 to 4 hours. (auth)

58329 GROWTH OF VOIDS IN STAINLESS STEEL. Buswell, J. T. (Berkeley Nuclear Labs., Eng.). pp 283-91 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Voids were grown in stainless steel foils by in-situ irradiation with 1-MeV electrons in a high-voltage electron microscope. Voids were produced during irradiation in the temperature range 450 to 600°C. The voids were generally octahedral in shape. The frequency of occurrence of voids increased with, and their size decreased with, the concentration of pre-injected helium. However, the presence of helium was not essential for void formation. The volume swelling ($\Delta V/V$) increased with an increase in the helium content. Volume changes in the range 0 to 2% were obtained. In this range $\Delta V/V \propto \text{dose}^2$. The characteristics of the nucleation and growth of voids, and the influence on those factors of the presence of precipitates, etc., are discussed. (auth)

58330 INFLUENCE OF HVEM IRRADIATION ON NEUTRON INDUCED VOIDS IN NICKEL. Harbottle, J. E. (Berkeley Nuclear Labs., Eng.). pp 293-300 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Pure nickel foils, previously irradiated by fast neutrons to doses between 2×10^{18} and 1×10^{20} cm^{-2} at temperatures of 50, 400, and 450°C were electron irradiated in the HVEM between 400 and 450°C. In this way the subsequent growth and shrinkage of voids under the influence of electron irradiation was studied in situ. For neutron doses $\geq 5 \times 10^{19}$ cm^{-2}, where observable voids are produced, the initially uniform distribution throughout the foil is modified by electron irradiation due to the surface denuded layers. Void growth occurs in a central region of thickness given by the ratio of the void concentrations and is correlated with their morphology as a function of electron dose. Initially $\{111\}$ octahedral voids convert by progressive $\{110\}$ truncations to a cubic shape, the transition coinciding with the onset of linear growth. The reduced void volume fraction increases linearly with displacement dose up to 9% at 45 d/a. Voids were grown by electron irradiation following low neutron doses $\sim 10^{18}$ cm^{-2} at 50°C, indicating that the transmuted helium concentration ($<10^{-6}$ at. %) necessary for nucleation is very low, and that the distribution of the gas is important. (auth)

58331 SIGNIFICANCE OF FAST NEUTRON INDUCED VOIDS IN THE DESIGN AND PERFORMANCE OF FAST REACTORS. Bishop, J. F. W. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 301-18 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Although void swelling is not a significant feature in the performance of existing fast reactors there are clear indications that at the higher temperatures and higher fast neutron fluences in projected power reactors the magnitude of void swelling will be such as to affect either the design of the core, the operational procedures, or choice of materials. The data areas on void formation are reviewed and evaluated and the need for extrapolation is discussed. Conditions of exposure for the various core components in power reactors are considered in relation to performance requirements. Alternative core concepts and design criteria are described, and the importance of radiation creep in limiting internal stresses is emphasized. (auth)

58332 COMPARISON OF THE DAMAGE STRUCTURE IN FAST REACTOR AND ACCELERATOR IRRADIATED MOLYBDENUM. Eyre, B. L.; Evans, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). pp 323-31 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Transmission electron microscopy was used to compare the structures of molybdenum irradiated with 2-MeV nitrogen ions in an accelerator at 870°C with similar material neutron-irradiated in the fast reactor at 650°C. The observations in the latter case confirmed the accelerator results where it was found that the voids aligned themselves into a regular array having body-centred cubic symmetry with crystallographic axes identical with those of the host lattice. The various features of the two sets of observations are discussed with the similar swelling at the widely separated irradiation temperatures being explained by the displacement rate difference. Reference is made to the theoretical explanation for the void lattice by Malen and Bullough (1971) and the possible practical importance of the lattice is indicated. (auth)

58333 CONTRIBUTION TO THE DISCUSSION ON NUCLEATION. Harbottle, J. E. (Berkeley Nuclear Labs., Eng.). pp 333 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Nickel foils, neutron irradiated to doses of $\sim 10^{18}$ cm^{-2} at 50°C, were irradiated by 1-MeV electrons in the HVEM and voids were observed to grow to a density of $\sim 10^{12}$ mm^{-3}. The concentration of transmuted helium ($\sim 10^{-6}$ at. %) is about the same as the intrinsic gaseous impurity of 4N5 purity nickel, yet only interstitial loops and not voids are grown on electron irradiation of pure nickel, possibly due to the low dislocation density in annealed material providing insufficient sinks for the interstitials. The similarities in void densities over a wide range of transmuted helium concentrations together with the fact that voids cannot be grown by electrons alone in 4N5 nickel suggest that the formation of void nuclei is controlled more by the relative distribution of gas atoms and their relationship with defects than by their quantity. (UK)

58334 KNOCK-ON OF GAS ATOMS INTO MATERIALS DURING IRRADIATION IN A GAS ATMOSPHERE. Migge, H. (Hahn-Meitner-Inst., Berlin). pp 335-6 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).
From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

The He content of silver foils of different thickness after irradiations under 600 torr He at 80°C is given. The fast fluence ($E > 0.1$ MeV) was 4×10^{17}/cm^2. The He content per cm^2 surface area of the sample increased linearly with increasing foil thickness up to a saturation value of 1.6×10^{12}/cm^2 at about 10^4 Å. From the constant initial slope of the curve, the He concentration was calculated to be 1.7×10^{16}/cm^3. The concentration fell quickly to zero at thicknesses $>10^4$ Å. An interpretation of the results is given. (UK)

58335 SOME OBSERVATIONS OF THERMAL RELEASE OF HELIUM FROM IRRADIATED NICKEL. Bergenlid, U.

XUM

(Aktiebolaget Atomenergi, Stockholm). pp 337-8 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Slightly boron-doped nickel specimens were irradiated to the order of 10^{20} n/cm^2 and the thermally activated release of helium measured. Results indicated that vacancy currents provide a mechanism for the transport of helium. A diagram is given showing the release rate peaks at each resistivity recovery stage. (UK)

58336 NEW SOURCE OF HELIUM IN CLADDING MATERIALS. Birss, I. R.; Ellis, W. E. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). pp 339-45 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

Recent measurements have shown unexpectedly high helium contents in cladding materials irradiated in thermal reactors, and the reaction $^{58}Ni(n,\gamma)^{59}Ni(n,\alpha)^{56}Fe$ was suggested to explain the effect. A cross section was derived for the second part of the reaction, and it was shown that the reaction rate is not significant either in DFR or PFR. (auth)

58337 DYNAMIC DISLOCATION PILE-UP IN NEUTRON-IRRADIATED METALS. Arsenault, R. J. (Univ. of Maryland, College Park). Phil. Mag.: 24: No. 188, 259-71(Aug 1971).

The formation of a dislocation pile up was examined for the condition where there is a finite removal probability of the short-range barriers to dislocation motion. The purpose of investigating this type of dynamic pile up formation was to determine whether the rapid rate of slip-line formation in neutron-irradiated metals could be a thermally activated process. The evidence obtained affirms the possibility of having slip lines form rapidly while the process is still thermally activated. (auth)

58338 ANELASTIC PROPERTIES OF IRRADIATED ALUMINUM COLD-WORKED AT LOW TEMPERATURE. Guenin, G.; Perez, J.; Gobin, P. F. (Institut National des Sciences Appliquees, Villeurbanne, France). Radiat. Eff.; 10: No. 1-2, 17-25(Jul 1971). (In French).

The influence of cold-work and of subsequent annealing on the anelastic properties of aluminum has been studied by several workers. The behavior of the cold worked metal can be analyzed in terms of elementary processes such as: Niblett and Wilks peak (B_1) and Bordoni peak (B_2); and the P_A, P_B, and P_C peaks due to the interaction between dislocations and point defects. Some effects due to additional point defects induced by neutron irradiation at 80°K prior to the plastic deformation are presented. Those effects can be summarized as follows. Niblett and Wilks peak (B_1) does not appear any more; by comparison with unirradiated aluminum, the Bordoni peak (B_2) on one hand is lower, and on the other hand increases more after an anneal at 220°K. The period anomaly $\Delta T/T_0$ is weaker in the whole spectrum and particularly at 10°K. Above 200°K, it increases (reversibly) until 300°K. A peak similar to the P_C peak of unirradiated aluminum is observed during the first temperature increase but this peak is annealed during observation. These results have been interpreted with the following assumptions: The B_1 and B_2 peaks are due to intrinsic properties of dislocations; $\Delta T/T_0$ is induced by the movement of geometrical kinks at low temperature (<100°K) and by break-away of dislocations at high temperature (between 200 and 300°K); and the peak observed near room temperature is a consequence of thermomechanical unpinning of dislocations from irradiation induced point defects. (auth)

58339 LOW TEMPERATURE DEFORMATION CHARACTERISTICS OF NEUTRON IRRADIATED VANADIUM–TITANIUM ALLOYS. Pink, E.; Arsenault, R. J. (Univ. of Maryland, College Park). Contract AT(40-1)-3612. Radiat. Eff.; 10: No. 1-2, 27-32(Jul 1971).

An investigation was undertaken to determine the effects of neutron irradiation on the low temperature deformation characteristics of vanadium–titanium alloys. The effects can be divided into two groups: for low titanium concentrations (0.75 and 1.6 wt % Ti) a weakening effect appeared which was apparent for the complete temperature range investigated for the 0.75% Ti but to a lesser extent for the 1.6% titanium alloy. For alloys with higher titanium concentration (4 to 20% Ti), the neutron irradiation did not affect the thermal component of the yield stress, i.e., no change in the rate-controlling mechanism of low temperature deformation occurred. For both alloy groups the neutron damage resulted in an increase in the athermal component of the yield stress. (auth)

58340 OBSERVATIONS OF A REGULAR VOID ARRAY IN HIGH PURITY MOLYBDENUM AND T.Z.M. IRRADIATED AT HIGH TEMPERATURES WITH 2 MeV NITROGEN IONS. Evans, J. H. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 10: No. 1-2, 55-60(Jul 1971).

Electron microscope observations are presented to demonstrate the existence of a three-dimensional defect array in high purity molybdenum, and in TZM irradiated at high temperatures with 2-MeV nitrogen ions to doses of approximately 10^{18} ions/cm^2. It was found that the defect array has a body centered cubic structure with a lattice parameter of 220 Å and with crystallographic axes coincident with those of the molybdenum matrix. The identification of the defects as voids is discussed together with possible mechanisms for the array formation. (auth)

58341 COMPLEX ANNEALING WITHIN STAGE I OF ALUMINUM. Chaplin, R. L. (Clemson Univ., S. C.). Radiat. Eff.; 10: No. 1-2, 61-4(Jul 1971).

Irradiating aluminum with 0.4 MeV electrons gave a component of damage which annealed in the 21 to 26 K temperature region that was independent of the I_B and I_C annealing stages. A detailed study has been made that proves this component of the damage is reproducible, increased with increasing irradiation energy, increased when aluminum is doped with copper, independent of crystallographic orientation, independent of irradiation dose, and also present from 27 to 29°K. It is proposed that this continuum type of recovery is caused by the annealing of point defects which reside at strained regions of a crystal. (auth)

58342 EFFECT OF NEUTRON IRRADIATION ON MECHANICAL PROPERTIES OF RHENIUM. Pitt, C. H.; Brimhall, J. L. (Battelle-Northwest, Richland, Wash.). Radiat. Eff.; 10: No. 1-2, 71-7(Jul 1971).

Polycrystalline and single crystal rhenium tensile specimens have been neutron irradiated at 50°C to fluences up to 2.6×10^{19} n/cm^2 and subsequently tested in tension. The microstructure of the single crystals was examined by transmission electron microscopy. The yield strengths of the polycrystalline specimens increased from 19,000 psi in the unirradiated material to 143,000 psi after a fluence of 2.6×10^{19} n/cm^2. Slip was observed on the basal and prismatic planes and $(11\bar{2}1)$ twinning was found to be the main twinning mode in the single crystals. The single crystal yield strengths also increased markedly with fluence and were found to increase at a greater rate in those crystals oriented for prismatic slip. The radiation damage greatly retarded twin growth at the higher fluences but did not appear to affect twin nucleation. Channeling of dislocation through the small defect clusters occurred in the irradiated specimens. Deformation twinning did not result in channeling type behavior although anomalous channels parallel to, but outside, the twins were observed. (auth)

58343 HEAT TREATMENT STUDIES OF IR ABSORPTION IN REACTOR-IRRADIATED GERMANIUM. Lin, K. C.; Chu, C. N.; Loh, S. Y.; Cheng, Y. C. Nucl. Sci. J. (Taiwan); 8: No. 1, 1-11(Apr 1971). (In Chinese).

The effects of transmutation-produced impurities (Ga, As, Se) and displaced atoms in germanium induced by nuclear reactor irradiation on infrared absorption were investigated by heat treatment. It was found that upon isochronal annealing in the temperature range between 50 and 500°C, two regions in which a marked decrease of infrared absorption takes place are observed; one from 70 to 130°C and the second from 270 to 500°C. Results obtained from isothermal annealing show that lattice defects resulting from atomic displacements can be completely removed by a vacuum anneal at 450°C for more than 14 hours. The results also indicate that the effects of displaced atoms on infrared absorption are greater than that of the transmutation-produced impurities. From these observations, the effective introduction rate of displaced atoms was estimated to be 0.015 displaced atoms per incident neutron with the assumption that two acceptors are produced for each displaced atom. This value is much smaller than the one theoretically calculated. Further analysis of the experimental results leads to the conclusion that the disagreement between observed and calculated results is likely due to the annealing of a majority of displaced atoms during the course of irradiation and that the survivals are mainly produced by the recoil effects resulting from (n,γ) reaction. Such displaced atoms are stable at room temperature for a relatively long period. (auth)

Ceramics and Cermets

Refer also to abstracts 58163 and 60010.

58344 (LA–4693) QUARTERLY STATUS REPORT ON THE ADVANCED PLUTONIUM FUELS PROGRAM, JANUARY 1–

MARCH 31, 1971. (Los Alamos Scientific Lab., N. Mex.). May 1971. Contract W-7405-eng-36. 27p. Dep. NTIS.

Activities in programs directed toward evaluation of neutron irradiation effects on LMFBR fuels are summarized. Progress is reported on equipment development, hot cell design modifications, methods for analytical measurements of U and Pu, irradiation testing of fuels, B_4C structural studies, and development of analytical standards for fast breeder oxide fuels. (J.R.D.)

Corrosion and Erosion

Refer also to abstracts 58168 and 58177.

58345 INVESTIGATION OF THE VOLATILIZATION OF MgO AND ZrO_2 IN OXIDIZING ATMOSPHERES. Karaulov, A. G.; Eltysheva, A. A.; Mayauskas, Yu. S.; Yanulis, V. V.; Grinyute, G. A. (Refractories Research Inst., Kiev. Inst. of Physico-technical Problems of Power Engineering, Vilnyus, USSR). Refractories (USSR) (Engl. Transl.); 12: No. 1-2, 121-4(Jan-Feb 1971).

Translated from Ogneupory; 12: No. 2, 49-53(Feb 1971).

The rates of volatilization of refractories made from magnesia and zirconia stabilized with CaO in an oxidizing atmosphere (in air) up to 1900°C are similar; above 2000°C the volatilization rate of magnesia sharply increases; and at 2200°C its magnitude is an order greater than in the specimens of zirconia. The volatilization rate of zirconium dioxide in an oxidizing atmosphere at the temperature of intensive volatilization (2300°C) is about the same as in an inert atmosphere. (auth)

Preparation and Fabrication

Refer also to abstracts 57397, 57653, 57655, 57723, 58187, 58200, 58207, and 59639.

58346 (CONF-711002--, pp 144-6) SIMPLE TECHNIQUE OF PRODUCING THIN CARBON FILMS. Maier-Komor, P. (Technische Universitaet, Munich (West Germany)). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

A method of preparing thin carbon films by evaporation is described. The process involves electrically evaporating a carbon rod at low pressure. A release agent is used composed of betaine monohydrate and D^+ sacharose. Carbon films in the range 3 $\mu g/cm^2$ to 250 $\mu g/cm^2$ can be produced. (J.R.D.)

58347 (JUL--730-RW) INVESTIGATION AND PREPARATION OF SPHERICAL DOPED UO_2 FUEL PARTICLES. A Report on the Clarification of the Retarding Power of Coated Particles for Solid Fission Products. Hamesch, Muwaffak (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Feb 1971. 119p. (In German). Dep. NTIS (U. S. Sales Only).

The suitability of known sol-gel methods for the introduction of solid fission products into UO_2 cores and the fission product retention capacity of bare and pyrocarbon-coated particles were studied. In the study of the sol-gel methods it was determined that the fission products Y, Zr, Nb, some rare earths, Al, and Mg were incorporated in amounts from 1 to 10 at. % into the spherical UO_2. The fission products Sr and Ba were simulated in amounts of the 0.8 to 2 at. %, which corresponds to a burn-up of 10%. The essential step in the introduction of Ba and Sr was the addition in the form of their nitrated to the washed $UO_2 \cdot nH_2O$ before peptization. A more accurate study showed that at sufficiently low pH values of the sol not Sr^{2+} or Ba^{2+} ions were washed from the gel particles during the washing with ammonia. The model particle obtained was characterized by chemical and γ spectrometric analysis with the help of metallographic and microprobe analysis and by measurement of the lattice constants. The dependence of the fission product release on the type of gas, the crucible material, the sintering method, the particle porosity, the particle composition, and the compatibility of the model particle with the crucible material. In the study of the dependence of the fission product release on the particle composition, temperature, and annealing time it was shown that the fission products Ba and Sr were released from the doped particle proportionally to the annealing duration and temperature. The particles which contain Nb or Al in addition to the fission products Ba or Sr show lower fission product loss in comparison with the particles without oxide additions. This model particle was coated with pyrocarbon by propene pyrolysis and an extended annealing of 500 hr at 1000, 1200, and 1550°C was investigated. The results showed that the fission product release of the model particle doped only with Ba or Sr increases with increasing annealing temperature. The coated particle which had an Al_2O_3 or Nb_2O_5 addition showed no fission product loss. By oxide additions such as Al_2O_3 or Nb_2O_5 to the UO_2 fuel particle an improvement of the retention capacity of the particle for Sr and Ba can be obtained. (tr-auth)

58348 (LFEN-NI--53-a) TECHNIQUES FOR PREPARATION OF UO_2--NIOBIUM (OR MOLYBDENUM) CERMETS. da Silva, C. Pacheco; Carvalhinhos, H.; Sampaio, A. Oliveira (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1969. 33p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

A bibliographic study was made of the techniques for the preparation of UO_2 cermets with Nb or Mo as the base metal and at UO_2 concentrations of at least 80% by volume. On the basis of the information gathered, a technique was selected which led to final products of high density and homogeneous structure. (tr-auth)

58349 (ORNL--4713) DEVELOPMENT OF MANUFACTURING PROCEDURES FOR HFIR FUEL PLATES TO ORNL SPECIFICATION. Knight, R. W.; Sherman, F. L. (Oak Ridge National Lab., Tenn.). Sep 1971. Contract W-7405-eng-26. 48p. Dep. NTIS.

Techniques for manufacture of High Flux Isotope Reactor (HFIR) fuel plates were originally developed at the Oak Ridge National Laboratory (ORNL). Since ORNL is not a manufacturing facility and many techniques had to be worked out to improve the efficiency of manufacture of precision parts at a high production rate, a great deal of the work had to be left to the contractor, Texas Instruments Inc. The development of these production procedures based on the ORNL original fabrication concept is described. Aspects of production such as fuel plate blisters, fuel core outlines, homogeneity measurements, and material are discussed. (auth)

58350 (RD/B/N--2020) METHOD FOR PRODUCING THIN FOILS FROM GRAPHITIC MATERIALS FOR TRANSMISSION ELECTRON MICROSCOPY. Baker, C. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jun 1971. 7p. Dep. NTIS (U. S. Sales Only).

It is shown how thin foils of a number of graphitic materials can be produced using ion beam thinning. The advantages of the method are that good foils can be made from graphites with a two phase binder/particle structure and also from pyrolytic graphites. In the latter case foils can be produced from any orientation. (auth)

58351 (RT/ING--(70)30) ACTIVITY AND INFRASTRUCTURE OF CNEN FOR THE REUSE OF PLUTONIUM FOR NUCLEAR FUEL. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). [nd]. 157p. (In Italian). Dep. NTIS (U. S. Sales Only).

The work done to give Italy a capacity for the production of nuclear fuels containing Pu is summarized. The experience at the Mol Pu laboratory in the training of technicians is reported. The production of microspheres of $(U,Pu)O_2$ by the SNAM and the CNEN methods is described. The preparation of fuel irradiation samples is also described. The Pu laboratory at Casaccia is described in detail with emphasis on the systems for the prevention and control of nuclear and nonnuclear incidents. Procedures used for the fabrication of fuel elements containing Pu are described. A series of tests in the materials testing reactor on Pu fuels is described. (J.S.R.)

58352 (Y-DA-2123(Rev.1)) PYROLYTIC CARBON INFILTRATION STUDIES. Taylor, A. J.; Paluzelle, R. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 8 Sep 1971. Contract W-7405-eng-26. 120p. Dep. NTIS.

Work done to produce and investigate both the conditions for successful infiltration and the characteristics of the deposited pyrocarbon is summarized. With the interest in pyC-infiltrated materials being related to inherently good ablation characteristics and, consequently, reentry vehicles, the scope of the work included an evaluation of techniques for joining felt to form structures of closed geometry or, preferably, generating the means for obtaining or fabricating these structures without seams. (auth)

58353 ATTACK POLISHING OF METALS AND CERAMICS. Ambler, J. F. R. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 1-6 of Proceedings of the Third Annual Technical Meeting of the International Metallographic Society, Inc. /Johnson, K. A. (ed.). Los Alamos, N. Mex.; International Metallographic Society, Inc. (1971).

From third meeting of the International Metallographic Society; Cleveland, Ohio (16 Nov 1970).

Attack polishing methods, in which the chemical reaction product is insoluble, can produce surfaces that are essentially flat and free from mechanical deformation. UO_2, U_3Si, and Zr alloys were used to show that these are important features for some applications. Attack polishing is not the ultimate polishing method for all ma-

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terials or for all applications. However, it is a useful additional metallographic technique that helps reveal the maximum amount of reliable information from specimens. (P.C.H.)

58354 CHEMICAL ETCHANT FOR $(PuTh)O_2$ CERAMIC MICROSCOPY. Baker, C.; Johnson, K. A. (Los Alamos Scientific Lab., N. Mex.). pp 7-8 of Proceedings of the Third Annual Technical Meeting of the International Metallographic Society, Inc. /Johnson, K. A. (ed.). Los Alamos, N. Mex.; International Metallographic Society, Inc. (1971).

From third meeting of the International Metallographic Society; Cleveland, Ohio (16 Nov 1970).

A method is described for the preparation and etching of $(PuTh)O_2$ sintered ceramics and cermets for optical microscopy. The materials were epoxy mounted and ground in three stages: 100, 320, and 600 grit. They were polished on vibratory polishers in two stages. The samples were then chemically treated with fresh solutions of 10 ml HI, 10 ml HCl, 4 drops HNO_3, and 4 drops HF. The etching solution is applied as a miniscus over the polished surface and the etching time is controlled by inspection. It was found convenient to etch for five minutes, rinse, and ultrasonically clean, and then examine the etch with a microscope. (P.C.H.)

58355 MANUFACTURING METHOD FOR NUCLEAR FUEL. (to Belgonucleaire). British Patent 1,229,388. 21 Apr 1971. Priority date 17 Apr 1969, Belgium.

An improved process for manufacturing fuel material for nuclear reactors, particularly gas-cooled reactors, is described. The nuclear fuel element produced consists of a graphite container at least partially filled with fuel particles substantially homogeneously dispersed in a consolidation paste. The particles and the paste are introduced into the container which is subjected to centrifugation about an axis differing from the axis of the container whereby the particles and paste are intimately dispersed. (L.C.L.)

58356 ELECTRO-EROSION RESISTANCE OF REFRACTORY CARBIDES WITHIN CORRESPONDING RANGES OF HOMOGENEITY. Lemeshko, A. M.; Naumenko, V. Ya.; Upadkhaya, G. Sh. Elektron. Obrab. Mater.; No. 4, 6-8(1970). (In Russian).

The resistance of refractory carbides (TaC, NbC, HfC, etc.) to electroerosion machining was studied as a function of C content within the corresponding ranges of homogeneity. The electroerosion resistance increased with increasing atomic number of the metal, and fell with increasing C content, except that in the case of TaC and NbC there was a maximum at the composition $MeC_{0.85}$. These effects were attributed to the influence of the stable sp^3 electron configurations of the C atoms and the d^5 configurations of the metal atoms. (Metals Abstr.)

58357 MAKING HEATING ELEMENTS ON THE BASIS OF ZIRCONIUM DIOXIDE FOR HIGH-TEMPERATURE FURNACES. Rutman, D. S.; Taksis, G. A.; Toropov, Yu. S.; Maurin, A. F. Refractories (USSR) (Engl. Transl.); 12: No. 1-2, 42-7(Jan-Feb 1971).

Translated from Ogneupory; 12: No. 1, 36-41(Jan 1971).

A technology was developed and resistor elements designed on the basis of zirconium dioxide for operation in air at up to 2100°C. A design was also developed for test rigs which include a furnace for individual testing of the heating elements and a furnace with three zirconia elements. An electric operating circuit with automatic control with respect to the working current of the heating elements was also developed. The results of tests show that in the working region of the furnace with three zirconia elements it is possible to carry out heating in an air atmosphere up to 1950°C, with a surface temperature on the high-temperature part of the heating elements of 2050 to 2100°C. One of the essential conditions for operating such furnaces is individual current regulation of each element. The furnace can be operated in laboratory testing using the heating elements singly, maintaining them at the maximum temperature for a period of several tenths of an hour. (auth)

58358 EFFECT OF SYNTHESIS TEMPERATURE ON THE SINTERING OF BORON NITRIDE. Repenko, K. N.; Getman, I. A. (Scientific-Research Inst. of Refractories, Kiev). Refractories (USSR) (Engl. Transl.); 12: No. 1-2, 110-15(Jan-Feb 1971).

Translated from Ogneupory; 12: No. 2, 37-43(Feb 1971).

Results of investigations are presented to show that the temperature used to obtain boron nitride has important effects on physical properties such as shape, crystal sizes, and crystal structure perfection on which the properties of the finished products depend. For the production of articles made by firing the raw materials in nitrogen, or hot pressing, it is necessary to use powdered boron nitride synthesized at 950°C, having a surface area of more than 40 m^2/g, and a defect crystal structure. (auth)

58359 EFFECT OF THE CRYSTAL STRUCTURE DISORDER OF BN ON ITS SINTERING. Poluboyarinov, D. N.; Kuznetsova, I. G.; Sadovskii, E. P.; Balashov, V. A. (Inst. of Chemical Technology, Moscow). Refractories (USSR) (Engl. Transl.); 12: No. 1-2, 99-104(Jan-Feb 1971).

Translated from Ogneupory; 12: No. 2, 27-32(Feb 1971).

The effects of crystal structure disorder in BN during sintering (under load and without load) were established. During hot pressing to achieve high density and strengths, only the powdered BN that has appreciable crystal structural distortions and high dispersion will sinter. After the hot pressing of these materials (mesographitic and turbostratic), and also after ordinary sintering, the BN has a graphitic structure. Results of investigations show that in production of sintered BN ceramics, by hot pressing and ordinary sintering, the synthesis of active BN powders having a disordered crystal structure and a high dispersion is feasible. (auth)

58360 CURRENT EFFICIENCY IN ALUMINA ELECTROLYSIS. II. DETERMINATION OF CURRENT EFFICIENCY. Botor, Jan. Rudy Metale Niezelaz.; 15: No. 8, 433-6(Aug 1970). (In Polish).

Four main methods for the determination of current efficiency are described: anodic gas analysis, statistical, radioisotope, and dissolution of non-active elements. The last method, based on neutron activation analysis in conjunction with γ spectrometry and utilizing small additions of metallic ^{110m}Ag radioisotope (half life 270 days) in the bath, is considered to be potentially the most promising. (Metals Abstr.)

58361 SILICON CARBIDE AS A REINFORCEMENT. Parratt, N. J. Composites; 1: No. 3, 141-4(Mar 1970).

Silicon carbide whisker crystals grown by vapor-phase transport techniques have very high strength and improved density as compared with fibers grown on W; they are also very economical. The as-grown whiskers must be dispersed into a slurry for cleaning in a hydrocyclone, then graded by screening and aligned by extrusion to orient them for maximum volume loadings. Light alloys are a particularly attractive matrix for these fibers, but much more developmental work is needed. Rapid forming of composites from Al alloys with short SiC whiskers has been particularly successful. The longest grades of SiC whiskers give good reinforcement in plastics. (Metals Abstr.)

58362 MANUFACTURING OF FUEL PELLETS WITH CENTER HOLES. Dippel, Th.; Guenther, E. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 16: No. 8-9, 431-2(Aug-Sep 1971). (In German).

Preparation of oxide fuel pellets with axial holes is possible if the holes are formed in non-sintered pellets. With the exception of minor technical equipment, the method requires only reliably pressed material. With respect to sintering, no special behavior is observed. Variations of density, length, and diameter are indistinguishable from that of normal cylindrical pellets. Refinement of the final products by additional shaping is possible. (tr-auth)

58363 FORMING PROCESSES FOR METAL MATRIX COMPOSITES. Cooper, G. Composites; 1: No. 3, 153-9(Mar 1970).

Metals as matrices appear potentially superior to polymers and ceramics because of their high strength and stiffness, insensitivity to temperature extremes and capacity for plastic deformation. Disadvantages are that metal-to-fiber bonds are poor when low-temperature fabrication is employed and that oxidation between fiber and matrix occurs when processing is at high temperature. Methods most commonly used for preparing metal/matrix composites include: liquid-metal infiltration, in which a molten metal such as Al is cast around fibers of nitrided B; vapor deposition, as in the deposition of Al on C fibers by the thermal decomposition of tri-isobutyl Al; electroforming, as in composites of C fibers coated with Ni, and the related process of plasma spraying in which Al is deposited on B fibers wound on an Al foil-covered drum; mechanical compaction in which wires of steel, B or silicon carbide are pressed into soft metals such as Al; and unidirectional solidification, a process in which melts of eutectic alloys such as those involving Ni, Al, and Nb solidify slowly under a thermal gradient to produce parallel rods of one phase dispersed in the other. (Metals Abstr.)

58364 VIBRATORY COMPACTION OF URANIUM DIOXIDE. II. COMPACTION OF SOL-GEL UO_2 POWDER WITH A PNEUMATIC VIBRATOR. Naruki, Kaoru (Power Reactor and Nuclear Fuel Development Corp., Tokai, Japan). J. Nucl. Sci. Technol. (Tokyo); 8: No. 9, 520-7(Sep 1971).

Vibratory compaction was studied making use of a pneumatic vibrator to pack sol-gel UO_2 powder in a thermal reactor type fuel canning tube. It is shown that the pneumatic vibrator utilized is superior to the commonly used electrodynamic vibrator from the viewpoint of easy operation and high attainable density. Compared with the latter type, the pneumatic vibrator is less restrictive in the range of mesh size composing each fraction of the starting powder, and good results could be obtained with a powder with coarse, medium, and fine fractions respectively having mesh ranges of 4 ~ 6 (60%), 20 ~ 65 (20%) and −200 (20%). The selected operational conditions are: vibration frequency 300 cpm, driving air pressure 3 kg/cm^2, and duration of operation 10 min. Fuel rods of 100 cm length compacted in these conditions with sol-gel UO_2 (particle density: 96% theoretical density T.D.) attained a bulk density of 88.2 ± 0.2% T.D. with an axial density distribution as uniform as ±3% T.D. (auth)

Properties Evaluations

Refer also to abstracts 57297, 57441, 57641, 57698, 58244, 58245, 58261, 58268, 58422, 59184, and 60243.

58365 (AI-AEC-12983) PREPARATION OF TUNGSTEN-MODIFIED MIXED CARBIDE. Ervin, Guy Jr.; Carroll, J. W. (Atomics International, Canoga Park, Calif.). [Mar 1970]. Contract AT(04-3)-824. 14p. Dep. NTIS.

After a survey of available methods of synthesis and fabrication of tungsten-modified mixed carbide, two methods were investigated in the laboratory, one of which is considered to be suitable for preparation of fuel for a swelling test. Sintering a mixture of (U,Pu)C and tungsten powders failed to dissolve a major part of the tungsten. The successful method was carbothermic reduction of a mixture of the oxides, UO_2, PuO_2, and WO_3, which yielded solid solutions of tungsten in single phase uranium plutonium monocarbide. (auth)

58366 (CEA-CONF-1820) DEVELOPMENT OF PROPERTIES OF NUCLEAR GRAPHITE OBTAINED BY A MIXTURE OF COKES. Cornuault, P.; Lore, J. (Compagnie Pechiney, Paris (France)); Rappeneau, J.; Yvars, M.; Mottet, P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1970]. 28p. (In French). Dep. NTIS (U. S. Sales Only).

A series of molded pitch bonded graphites having as filler materials various proportions of mixtures of two different cokes was studied. One of these cokes is isotropic, the other is a fibrous conventional coke. The physical, mechanical, and thermal characteristics were studied for each product. The measured properties usually conform with the mixtures law. Dimensional variations caused by neutron irradiation were determined by a bromation method. These properties also also conform with the mixtures law. By mixing different cokes, nuclear graphites can be obtained having desired properties. It is possible to modify the graphite grade fluctuations associated with raw materials. (auth)

58367 (EUR-4327) RELEASE OF GASEOUS FISSION PRODUCTS FROM CARBONS. Barth, F. (European Atomic Energy Community. Brown Boveri/Krupp Reaktorbau GmbH, Mannheim (West Germany). Kernforschungsanlage, Juelich (West Germany)). 1969. 214p. (In German). NTIS (U. S. Sales Only).

Graphite is used both as moderator and a cladding or filler material in the development of fuel elements for high temperature gas-cooled reactors, because of its good heat resistance. However, the structural composition of graphite gives rise to certain problems relating to the release of fission products from the elements. This applies chiefly to cases in which the actual nuclear fuel is in the form of UO_2 or UC_2 embedded in a graphite matrix. Fission products expelled from the nuclear fuel by a recoil mechanism are taken up by the graphite, so that their release from the element is determined by the retentive capacity of the graphite. The problem of the release of gaseous fission products from carbon is discussed. The aim of the studies was, therefore, to elucidate the release of gaseous fission products, although in the meantime interest shifted to the problem of the release of nonvolatile fission products from carbon. (auth)

58368 ELECTRIC CONDUCTIVITY OF SOLID SOLUTIONS OF $(ThO_2)_{0\ 75} - (CeO_2)_{0\ 25}$ AT HIGH TEMPERATURE. Hammou, A.; Deportes, C.; Robert, G.; Vitter, G. (Domaine Univ., Saint-Martin d'Heres, France). Mater. Res. Bull.; 6: No. 9, 823-32 (Sep 1971). (In French).

The electric conductivity of the solid solution $(ThO_2)_{0.75}$–$(CeO_2)_{0.25}$ is studied as a function of temperature (1000 to 1500°C) and oxygen partial pressure (1 to 10^{-20} atm). The transport number measurements indicate a preponderant electronic conductivity. Both conductivity and resistance to chemical corrosion of this compound are compared with several conductive ceramics; the latter appear a promising material for "hot electrodes" in MHD generators. (auth)

58369 CRYSTAL GROWTH OF V_nO_{2n-1} ($3 \le n \le 8$) BY THE CHEMICAL TRANSPORT REACTION AND ELECTRICAL PROPERTIES. Nagasawa, Noichi (Kyto Univ.). Mater. Res. Bull.; 6: No. 9, 853-63(Sep 1971).

Single crystals of the intermediate vanadium oxides between V_2O_3 and VO_2 with the general formula V_nO_{2n-1} ($3 \le n \le 8$) were grown by the chemical transport reaction using $TeCl_4$ as a transport agent. The reactions were carried out in sealed tubes with the temperature gradient between 1050 and 950°C. The sizes of crystals produced were about 1 ~ 10 mm. The electrical properties of the crystals are summarized. (auth)

58370 DIFFUSION OF OXYGEN IN ZIRCONIA AS A FUNCTION OF OXYGEN PRESSURE. Keneshea, F. J. (Stanford Research Inst., Menlo Park, Calif.); Douglass, D. L. Oxidation Metals; 3: No. 1, 1-14(Jan 1971).

Diffusion of oxygen in monoclinic zirconia was studied using the oxygen-18 gas–solid exchange technique. The zirconia was in the form of spheres prepared by dropping the powdered material through a high temperature plasma. Diffusion was measured as a function of equivalent oxygen pressure, using oxygen and $CO-CO_2$ mixtures, over the range 1 to 10^{-21} atm. In pure oxygen at 700 torr and between 600 and 1000°C, the diffusion is described by the equation, $D^* = 2.34 \times 10^{-2} \exp - (45{,}300 \pm 1200)/RT$. Experiments in $CO-CO_2$ mixtures at 850°C gave self-diffusion coefficients that showed a slight decrease with a decrease in p_{O_2} from 1 to 10^{-6} atm, then a constant value of D^* from 10^{-6} atm, and finally a decrease in D^* from 10^{-19} to 10^{-21} atm. The behavior of D^* with p_{O_2} appears to be in agreement with a defect model involving anti-Frenkel imperfections, i.e., oxygen interstitials and anion vacancies, if it is assumed that the mobility for oxygen interstitials is greater than that for oxygen vacancies. (auth)

58371 STORAGE BEHAVIOR OF SINTERED URANIUM OXIDES. Constantinescu, F.; Prodan, A.; Toacsan, M. (Institut de Physique Atomique, Bucarest). Rev. Roum. Phys.; 16: No. 5, 583-5(1971). (In French).

Calculations were made on the O/U ratio for stored sintered uranium oxides with different specific surfaces. The results showed that the rate of increase in the O/U ratio is proportional to the specific surface. Experimental studies were made on the specific surface order to determine if the differences between the calculated data and the experimental data are not due to a modification in grains, with time, under the influence of air. The results showed a decrease in the value of the specific surface with time; the uranium oxide powders undergo some transformations during storage besides that concerned with the O/U ratio and the grain texture. The modifications made evident by the variation in the values for specific surface entail also the modification of the behavior of the sintered powders. (P.C.H.)

58372 QUANTUM MECHANICAL CALCULATIONS OF EMPIRICAL POTENTIALS BY PERTURBATION METHOD AND OXYGEN DIFFUSIVITY IN POLYCRYSTALLINE Pr_7O_{12}. Fox, Donald Lee. Tucson, Ariz.; Arizona State Univ. (1971). 158p. University Microfilms Order No. 71-18,961.

Thesis.

Part I involves the development and application of a perturbation method designed to investigate empirical potentials of a diatomic molecule having a form similar to the Morse potential. By making small corrections on the Morse potential, the effects of these corrections can be investigated with the perturbation theory. Each of these potentials consists of two parts, i.e., the Morse potential and a correction term. By using perturbation theory, the corrected potential energies and wave functions are obtained. As an application, four generalized Morse potentials are studied. The performance of these four potentials is evaluated against other empirical potentials as to their ability to predict spectroscopic constants and reproduce the experimental curves. The four potentials were found better than average at predicting spectroscopic constants, but poor at reproducing the potential energy. Franck–Condon factors are also calculated from corrected wave functions. The usefulness of this perturbation method lies in the fact that it gives analytical expressions for both eigenvalues and eigenfunctions. In Part II, the oxygen self-diffusion coefficient was measured in polycrystalline $PrO_{1.714 \pm \delta}$ by a method of heterogeneous isotope exchange. The studies were made at various temperatures and pressures. The dependence of the diffusion coefficient with pressure at a given temperature shows curvature with the slope decreasing with increasing temperature. Various mechanisms for mass transport are discussed to rationalize the experimental behavior. Information about the structure and conductivity is used to propose a complex mechanism involving competing defects. Similar

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mechanisms proposed in other systems are discussed in their relation to PrO_x. A mechanism involving charged and uncharged oxygen interstitials is proposed to explain the curvature and change in pressure dependences. At high temperature and low pressures, it is suggested that oxygen vacancies become significant. (Diss. Abstr. Int., B)

58373 KINETICS OF HYDROGEN ENGASSING OF DELTA-ZIRCONIUM HYDRIDE. Paetz, Peter; Luecke, Kurt (Interatom, Bensberg, Ger. Technische Hochschule, Aachen). Z. Metallk.; 62: No. 9, 657-62(Sep 1971). (In German).

The kinetics of hydrogen engassing of δ zirconium hydride was measured in the temperature range from 650 to 800°C. The hydrogen absorption by zirconium hydride follows a parabolic time law and the rate constant k is proportional to the concentration difference and to the square root of the diffusion constant. The temperature dependence of diffusion is given by $D = 0.25 \exp [(-17.8 \times 0.2)/RT]$. The activation energy indicates an indirect site exchange mechanism of the hydrogen atoms from tetrahedral to octahedral interstices. (auth)

58374 EFFECT OF OXYGEN PRESSURE ON THE REDOX POTENTIAL OF MOLTEN MOLYBDENUM TRIOXIDE. Rahmel. A. (Dechema-Inst., Frankfurt am Main). Z. Phys. Chem. (Frankfurt); 74: No. 3-6, 206-15(May 1971). (In German).

The effects of oxygen pressure and low-valence molybdenum oxides on the redox potential of a MoO_3 melt were measured at 850°C. An oxygen electrode with ZrO_2 as the solid electrolyte was used as the reference electrode. The results of the measurements allow the conclusion that the equilibrium $MoO_3 = MoO_{2.5} + \frac{1}{4} O_2$ is established between melt and gas atmosphere. The estimated value of the equilibrium constant is $K \approx 2.3 \times 10^{-3}$ at^{¼}. It may be assumed that the MoO_3 melt has partial electronic conductivity increasing as the oxygen pressure decreases. (auth)

58375 PROPERTIES OF CERAMIC COATINGS OF PHOSPHATE CERAMICS. Verenkova, E. M.; Trofimov, M. G.; Frolov, A. S.; Dikaya, K. I. (All-Union Scientific-Research Inst. of Aviation Materials, Moscow). Refractories (USSR) (Engl. Transl.); 12: No. 1-2, 48-52(Jan-Feb 1971).

Translated from Ogneupory; 12: No. 1, 41-5(Jan 1971).

The phosphate ceramic coatings made from Al_2O_3 and from ZrO_2 containing ortho- and metaphosphate of aluminum, in terms of properties such as adhesion, thermal-shock resistance, and impact strength are better than other coatings based on Al_2O_3 and ZrO_2. The low thermal conductivity, the appreciable bonding strength with metals and alloys, and the high thermal-shock resistance are the basis for recommending the coatings for protecting metals and alloys exposed to the action of high-temperature gas currents. (auth)

58376 STATISTICAL METHODS OF DETERMINING THE THERMAL-SHOCK RESISTANCE OF REFRACTORIES. Dauknis, V. I.; Peras, A. Ya.; Prantskyavichyus, G. A.; Yurenas, V. L. (Inst. of Physicotechnical Problems of Power Engineering, Vilnyus, USSR). Refractories (USSR) (Engl. Transl.); 12: No. 1-2, 125-8(Jan-Feb 1971).

Translated from Ogneupory; 12: No. 2, 53-6(Feb 1971).

A statistical analysis of the test results for the thermal-shock resistance of a large batch of specimens of zirconium dioxide established that there is satisfactory correspondence between the experimental data and the exponential distribution of Weibull. The appreciable spread in the thermal-shock resistance criteria R for brittle refractory materials should be considered as regular, and therefore to obtain reliable calculation characteristics for thermal-shock resistance it is necessary to treat the test results statistically. It is proposed that one of the causes of variation in the thermal-shock resistance criterion R is the slight (unavoidable even within the limits of a single batch of specimens) change in the density of the material. (auth)

58377 MASS SPECTRUM OF ZIRCONIUM BOROHYDRIDE. Khodeev, Yu. S.; Kirin, B. M. (Inst. of High Temperatures, Moscow). Zh. Strukt. Khim.; 12: No. 3, 531-2(May-Jun 1971). (In Russian).

The mass spectrum of $Zr(BH_4)_4$ exhibited a large quantity of lines, attributed to the presence of five Zr isotopes, two B isotopes, and possibly ionized H atoms. A contrast between this spectrum and that of $Be(BH_4)_2$ is discussed. (K.S.W.)

58378 HELIUM ESCAPE FROM IRRADIATED BORATED MATERIALS WITH CARBON–GRAPHITE MATRIX. Emel'yanov, I. Ya.; Grebennikov, R. V.; Moiseev, D. N.; (and others). At. Energ. (USSR); 31: No. 3, 215-18(Sep 1971). (In Russian).

The results of temperature dependence studies of helium escape from irradiated borated samples with a carbon-graphite matrix are presented. Tests were conducted in a highly sensitive facility developed on the basis of the reconstructed PTI-6-type leak detector. The procedure used made it possible to determine the activation energy of helium escaping from irradiated materials when heated as a function of properties and dimensions of boride phase particles and matrix structure. At low temperatures (200 to 300°C), an increase in helium escape was observed for irradiated samples having finer boride phase and porous carbon–graphite matrix. (auth)

58379 IONIC TRANSPORT NUMBERS OF GROUP IIa OXIDES UNDER LOW OXYGEN POTENTIALS. Alcock, C. B.; Stavropoulos, G. P. (Univ. of Toronto). J. Amer. Ceram. Soc.; 54: No. 9, 436-43(Sep 1971).

The ionic transport numbers of BeO, MgO, CaO, and SrO in single-crystal and polycrystalline samples were examined under low oxygen potentials between 900 and 1180°C. The oxygen potentials were fixed by using metal/metal-oxide electrodes in electrochemical cells with the samples of the alkaline earth oxides as solid electrolytes. The electromotive forces of these cells were compared with the emf values obtained from similar cells of high stability using high-purity thoria-based electrolytes. From the results it could be concluded that under comparable conditions of low oxygen pressure the electron transport number increases with increasing ionic radius of the group II element. Only BeO and MgO approach electrolytic behavior, and this occurs at relatively high oxygen pressures ($>10^{-10}$ atm). (auth)

58380 DYNAMIC BEHAVIOR OF DISPERSED INHOMOGENEOUS SYSTEMS. Leiber, C. O. Planseeber. Pulvermet.; 19: No. 1, 25-36(Mar 1971). (In German).

For the case of discontinuities present in a matrix which are small relative to the impact rise length and which behave as first-order acoustic oscillators, it is shown that the application of a dynamic load results in behavior radically different from that of homogeneous materials when the discontinuities carry out a mass-controlled motion. The range of onset of this motion depends on the density ratio, the diameter of the discontinuity, the viscosity and shear modulus G" of the matrix, and the impact gradient in the matrix. Consequently, there occurs in the mass-controlled range of motion, additionally to the hydrodynamic pressure, pressure oscillations superposed on the former, which determine the strength of the overall system. For the case of WC–Co cemented carbide, the effect of various defects (discontinuities) in dynamical load situations is analyzed. (auth)

58381 RESIDUAL STRESSES IN CERMETS. Bol'shakov, P. P.; Lanin, A. G.; Portnov, V. F. Tr. Leningrad. Politekh. Inst.; No. 305, 22-8(1970). (In Russian).

Using an x-ray method, with precision of ±20 MN/m^2 (2 kg/mm^2), determinations were made of residual stresses in specimens of the 85% ZrC + 15% Zr cermet. The method was used to study the behavior of specimens subjected to cyclic temperature changes. The upper temperatures were 1500, 1800, and 1950°C and the lower temperature 250°C in each case. The rates of heating and cooling were 250 and 25°C/sec, respectively. (Referativnyi Zh.)

58382 SURFACE CHANGES IN CARBON FIBERS DURING GRAPHITIZATION. Donnet, J. B.; Dauksch, Helmuth (CNRS, Mulhouse, France). J. Microscop.; 10: No. 3, 337-40(Apr 1971). (In French).

AC type carbon fibers were heated to 2500°C and converted into AG type graphite fibers by graphitization. Young's modulus, rupture strength, and the size of the crystallites as determined by x-ray crystallography are given. The shear strength of epoxide resins reinforced with AC or AG fibers was determined. (France)

58383 EFFECT OF A STEADY ELECTRIC FIELD ON THE DIFFUSION OF OXYGEN THROUGH POLYCRYSTALLINE LAYERS OF CARBON OR VANADIUM PENTOXIDE. Kulicki, K.; Skulski, L. (Technical Military Academy, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci., Math. Astron. Phys.; 19: No. 6, 551-6(1971).

Studies were performed on a directed oxygen diffusion through thin polycrystalline layers made of carbon or V_2O_5 (separating, at the beginning of experiments, two chambers filled with pure oxygen and argon, respectively) under the influence of a constant electric potential difference applied perpendicularly to the layers. It is shown that there is an apparent dependence between the amount of oxygen diffusing through the layers and the direction of the applied steady electric field. The oxygen diffusion was markedly faster when the negatively charged electrode was on the side of the oxygen-filled chamber, whereas the positively-charged electrode was then in the chamber filled with argon, which was subsequently analyzed for the content of oxygen. (auth)

58384 STUDIES OF VIBRATION SPECTRA OF BONDED HYDROGEN ATOMS USING A PULSED NEUTRON SOURCE.

Day, D. H.; Sinclair, R. N. (Atomic Energy Research Establishment, Harwell, Eng.). J. Chem. Phys.; 55: No. 6, 2807-11 (15 Sep 1971).

The vibration spectra of some hydrogeneous compounds have been studied over the range 300 to 4000 cm^{-1} by observing incoherent neutron scattering. The paper describes the use of a crystal analyzer technique with a pulsed neutron source based on the Harwell 45-MeV electron linac. Time-of-flight spectra of neutrons downscattered to a final energy, fixed by the crystal spectrometer, were measured. Data for ZrH_2, H_2O, $NaNH_2$, and $C_6H_5NH_2$ are reported and compared with available results from optical spectroscopy and, in the first two cases, other neutron-scattering data. (auth)

58385 THERMAL CONDUCTIVITY OF CERAMICS BASED ON BORON NITRIDE AND ALUMINUM NITRIDE. Duderov, Yu. G.; Kiryutin, A. K. (Moscow Engineering-Physics Inst.). Refractories (USSR) (Engl. Transl.); No. 9-10, 587-8(Sep-Oct 1970).

Translated from Ogneupory; No. 9, 54-5(Sep 1970).

Results of experimental work on the thermal conductivity of ceramics composed of 50% AlN + 50% BN are reported. Material preparation is described and resulting data obtained at 1000 to 1600°C are presented graphically. (J.R.D.)

58386 COMPARISON OF TWO METHODS FOR TESTING THE ABRASIVE RESISTANCE OF REFRACTORIES. Kamenetskii, A. B.; Gladkaya, N. V. Refractories (USSR) (Engl. Transl.); No. 9-10, 652-5(Sep-Oct 1970).

Translated from Ogneupory; No. 10, 41-5(Oct 1970).

Results of abrasion tests on refractories using gas borne fused corundum particles are compared with tests on similar materials using a cutting wheel tipped with diamonds. It was found that the abrasion test methods are comparable and that wear resistance depends on crystal hardness and matrix bond strength. (J.R.D.)

Structure and Phase Studies

Refer also to abstracts 57693, 58264, 58272, and 58290.

58387 (ANL-7823) CHEMICAL ENGINEERING DIVISION PHYSICAL CHEMISTRY OF LIQUID METALS AND MOLTEN SALTS SEMIANNUAL REPORT, JANUARY–JUNE 1971. Cairns, E. J.; Cafasso, F. A.; Cunningham, P. T.; Eberhart, J. G.; Feder, H. M.; Maroni, V. A.; Schnyders, H. C.; Veleckis, E.; Tevebaugh, A. D.; Vogel, R. C. (Argonne National Lab., Ill.). Jul 1971. Contract W-31-109-eng-38. 62p. Dep. NTIS.

The thermodynamic and chemical properties of liquid metals and molten salts continue to be of interest. Partial phase diagrams for the lithium-sulfur and lithium-tellurium systems are reported. Pseudo-ternary systems of the type lithium chalcogenide-chalcogen-alkali halide eutectic have been studied by several techniques, including emf measurement, and thermodynamic and phase data are reported. Refinements in a model for calculating the solubility of noble gases in liquid metals have been made. Raman spectroscopy has been used to study the structure of divalent metal halides and polyatomic anions in melts. Preliminary studies of lithium-hydrogen-metal systems of importance to fusion reactors are reported. A study of the homogeneous nucleation of vapor bubbles in superheated liquids has been started. (auth)

58388 (MLM-OP-71006) QUANTITATIVE ANALYSIS OF A CERMET SPHERE. Kelly, M. D.; Selle, J. E. (Mound Lab., Miamisburg, Ohio). [nd]. 14p. (CONF-710902-4). Dep. NTIS.

From fourth annual meeting of the International Metallographic Society; Denver, Colo. (21 Sep 1971).

A ThO_2–molybdenum cermet sphere was fabricated as part of the development effort relating to the Multi-Hundred Watt heat source program. Molybdenum-coated ThO_2 shards were pressed into a 1½ inch diameter sphere using graphite dies. The graphite was removed by machining leaving the composite sphere. The sphere was sectioned through the poles, metallographically polished, and analyzed using the Leitz Classimat to determine pressing characteristics. Density, form factor, particle size, composition, and orientation measurements were taken. Metallographic procedures, as well as the operation of the Classimat and the interpretation of the composite sphere data, are discussed. (auth)

58389 (SRO-552-8) QUANTITATIVE DETERMINATION OF THE STRUCTURE-PROPERTY RELATIONSHIPS IN NUCLEAR FUEL ELEMENT MATERIALS. Quarterly Progress Report, March 15, 1971–June 15, 1971. Rhines, F. N.; DeHoff, R. T.; Whitney, E. D. (Florida Univ., Gainesville. Dept. of Metallurgical and Materials Engineering). Jul 1971. Contract AT-(38-1)-552. 76p. Dep. NTIS.

Results of studies on gas permeability, thermal conductivity, short-time mechanical properties, and creep behavior of Ni and UO_2 powders are reported. Quantitative microscopic data support the hypothesis that both the nickel and UO_2 powders follow paths of microstructural change which are quantitatively very close to that found for a broad range of equiaxed metal powders. The permeability of nickel sinterings to gas flow varies with the amount of porosity along a path which is parallel to that observed for the variation of genus with porosity in earlier work. Differences in permeability for sinterings obtained from three different particle sizes could be accounted for by a scale factor which is proportional to the initial particle size. Initial measurements of permeabilities of UO_2 sinterings were an order of magnitude lower than those measured for nickel sinterings of comparable internal microstructural state. First measurements of the thermal conductivity of porous UO_2 are below values reported for fully dense UO_2, in qualitative agreement with predicted behavior. Continuing measurements of the tensile properties of nickel sinterings are consistent with earlier findings that the short time mechanical properties increase with density, and are insensitive to differences in the scale of the system. Mechanical properties of UO_2 also follow this pattern, although much additional data is required to establish the correlation. (auth)

58390 LIQUIDUS DETERMINATIONS IN THE PSEUDO-TERNARY SUB-SYSTEM $CaO.Nb_2O_5$–$CaO.TiO_2$–SiO_2 OF THE QUARTERNARY SYSTEM CaO–Nb_2O_5–TiO_2–SiO_2. Jongejan, A.; Wilkins, A. L. (Dept. of Energy, Mines, and Resources, Ottawa). J. Less-Common Metals; 25: No. 2, 109-14(Oct 1971).

Liquidus temperatures in the $CaO \cdot Nb_2O_5 - CaO \cdot TiO_2 - SiO_2$ plane of the $CaO - Nb_2O_5 - TiO_2 - SiO_2$ phase tetrahedron have been determined using the customary quench technique as well as hot-stage microscopy. The $CaO \cdot Nb_2O_5$ and $CaO \cdot TiO_2 \cdot SiO_2$ fields have been outlined. They are wedged between the SiO_2 and $CaO \cdot TiO_2$ fields and appear to have a small boundary in common. (auth)

58391 COMMENT ON THE DEFECT STRUCTURE AND THE TRANSPORT PROPERTIES OF Nb_2O_5. Streiff, R.; Poulton, D. J.; Smeltzer, W. W. (McMaster Univ., Hamilton, Ont.). Oxidation Metals; 3: No. 1, 33-9(Jan 1971).

The defect structure of oxygen-deficient $H-Nb_2O_5$ in several phases was interpreted using a model for correlating the results of electric conductivity measurements and oxygen diffusion parameters with the degree of nonstoichiometry. (J.R.D.)

58392 SUBSTRUCTURE OF γ-VANADIUM SUBOXIDE RESULTING FROM LONG RANGE ORDERING OF OXYGEN. Cambini, M. (CCR-EURATOM, Petten, Netherlands); Pellegrini, G.; Amelinckx, S. Mater. Res. Bull.; 6: No. 9, 791-803(Sep. 1971).

The substructure of the oxide formed by the oxidation of vanadium foils in the range $VO_{0.5}$ has been studied by means of electron microscopy, electron diffraction, and x-ray diffraction. A new phase, called the γ-phase, has been characterized and its relation to the previously known β-phase has been established. The substructure of the γ-phase consists of twins and APB's of different type. (auth)

58393 CRYSTÁLLOGRAPHY OF V_nO_{2n-1} ($3 \leq n \leq 8$). Horiuchi, Hiroyuki (Osaka Univ.); Tokonami, Masayasu; Morimoto, Nobuo; (and others). Mater. Res. Bull.; 6: No. 9, 833-43 (Sep 1971).

Single crystals of vanadium oxides, V_nO_{2n-1} ($3 \leq n \leq 8$), which were synthesized by the chemical transport method, have been studied by the x-ray single-crystal method. The lattices (a_n, b_n, and c_n) of the homologous series with $4 \leq n \leq 8$ can be systematically described on the basis of the parent rutile-type lattice (a_r, b_r, and c_r) as follows: $a_n = -a_r + c_r$, $b_n = a_r + b_r + c_r$, and $c_n = \frac{1}{2}(2n-1)(b_r + c_r)$. These relations can be explained on the basis of the "shear" structures of V_nO_{2n-1} described by Andersson and Jahnberg (1963). The crystal of V_3O_5 has been found to belong to the space group $P2_1/n$, but can be related to the homologous series of V_nO_{2n-1} by adopting the lattice with $2a_n$, b_n, and c_n. (auth)

58394 COLLECTIVE RECRYSTALLIZATION IN ZIRCONIUM CARBIDE AFTER SURFACE COLD-HARDENING. Bozhko, S. A. Izv. Akad. Nauk SSSR, Metal.; No. 6, 212-14(Nov-Dec 1970). (In Russian).

The recrystallization of ZrC on annealing at 1600 to 2000°C after hardening the surface by cold working was studied and isotherms of the corresponding grain-growth characteristics were plotted. Starting at 1750 to 1800°C, collective recrystallization developed. The activation energy of this process diminished with increasing number of C vacancies in the ZrC lattice, being commensurable with the activation energy for boundary diffusion. (Metals Abstr.)

58395 STRESS CHANGES IN TANTALUM CARBIDE WITH THE DEFORMATION RATE AND TEMPERATURE (1,200 AND 2,200^{0}C). Martin, J. L.; Lacour-Gayet, Philippe; Costa, Paul (National d'Etudes et de Recherches Aerospatiales, Chatillon, France). Compt. Rend., Ser. C; 272: No. 26, 2127-30(28 Jun 1971). (In French).

Circular bending tests revealed a microdeformation step, still observable at low temperatures (800°C). Two types of laws are proposed to explain the stress variation with the deformation rate and temperature for a plastic deformation $\epsilon_p = 1.2 \times 10^{-3}$; both laws take into account internal stresses which are important at high temperatures, high activation enthalpies (>5 eV) and activation volumes of at least 50 b^3. (France)

58396 PROCEEDINGS OF THE THIRD ANNUAL TECHNICAL MEETING OF THE INTERNATIONAL METALLOGRAPHIC SOCIETY, INC., CLEVELAND, OHIO, NOVEMBER 16–18, 1970. Johnson, K. A.; Bender, J. H. (eds.). Los Alamos, N. Mex.; International Metallographic Society, Inc. (1971). 193p. (CONF-701118).

Twenty-five articles are included; separate abstracts were prepared for 10. One article on preparation of irradiated Liquid Metal Fast Breeder Reactor (LMFBR) prototypic fuels for metallography was previously included in NSA as 25: 22138. Abstracts only were included for two articles on transmission electron microscopy of boron carbide and effects of cold work and aging on the substructure and precipitation phenomena in the Co-base alloy L-605. The remaining 12 articles contained information on: effect of stress on precipitation in Type 316 stainless steel; a simplified electron probe microanalyzer; video techniques with an EM-200 electron microscopy; microstructural changes on austenitizing and tempering of M50 high-speed steel; phase identification etchants for Fe–Cr–Ni alloys; metallographic applications of xenon lamp systems; minimum error analysis for automatic image analyzing; metallography of rapidly solidified Al–Cu alloys; metallography of archeological artifacts; relation between ultrasonic scatter in the Rayleigh range and the metallographic structure of Al–Si alloys; exsolution in magnetite and ilmenite from granite and pegmatite; and metallography of barrier and sacrificial coatings. (P.C.H.)

For abstracts of individual papers see: 57627, 57693, 58174, 58190, 58353, 58354, and 58397–58400.

58397 EXAMINATION OF THE MICROSTRUCTURES OF MIXED URANIUM–PLUTONIUM DIOXIDE FUEL PELLETS FOR FAST FLUX IRRADIATION STUDIES. Chang, J. Y.; French, P. M.; Jacoby, W. R.; Shalek, P. D. (Westinghouse Electric Corp., Cheswick, Pa.). pp 41-56 of Proceedings of the Third Annual Technical Meeting of the International Metallographic Society, Inc. /Johnson, K. A. (ed.). Los Alamos, N. Mex.; International Metallographic Society, Inc. (1971).

From third meeting of the International Metallographic Society; Cleveland, Ohio (16 Nov 1970).

Mixed-oxide fuel pellets of the composition $(U_{0.75}Pu_{0.25})O_{1.95 \text{ to } 1.99}$ and having nominal densities of 90 and 95% of theoretical were fabricated and characterized for fast flux irradiation studies in the EBR-II reactor. Metallographic, microhardness and autoradiographic data obtained at various stages in the program were used to identify the source and nature of secondary phases which could occur in the pellets. In addition, microstructural characteristics such as porosity and microcracking were found to be related to the type and method of binder addition as well as the preslugging and pelletizing pressures used in the fuel fabrication process. (auth)

58398 METALLOGRAPHIC ANALYSIS OF CERMET FUEL FORMS. Kelly, M. D.; Selle, J. E. (Monsanto Research Corp., Miamisburg, Ohio). Contract AT(33-1)-GEN-53. pp 89-93 of Proceedings of the Third Annual Technical Meeting of the International Metallographic Society, Inc. /Johnson, K. A. (ed.). Los Alamos, N. Mex.; International Metallographic Society, Inc. (1971).

From third meeting of the International Metallographic Society; Cleveland, Ohio (16 Nov 1970).

Metallography was performed on solid solution cermet fuel forms used in radioisotopic heat sources. Coprecipitated PuO_2–ThO_2 solid solution shards were molybdenum coated and pressed into a pellet. During the development of the pressing parameters, cracking, graphite reactions, twinning, and other microstructures were observed. These structures and their causes along with the metallographic techniques are discussed. (auth)

58399 METALLOGRAPHIC ANALYSIS OF CARBIDE STRUCTURES IN CAST HEAT-RESISTANT ALLOYS. Price, C. W.; Johnson, D. W.; Beuhring, V. F. (Battelle Memorial Inst., Columbus, Ohio). pp 135-9 of Proceedings of the Third Annual Technical Meeting of the International Metallographic Society, Inc. /Johnson, K. A. (ed.). Los Alamos, N. Mex.; International Metallographic Society, Inc. (1971).

From third meeting of the International Metallographic Society; Cleveland, Ohio (16 Nov 1970).

Extensive metallographic studies have been conducted on carbide structures in experimental iron, nickel, chromium cast heat-resistant alloys. These studies included optical metallographic, scanning electron microscopy (SEM), x-ray diffraction (XRD), and electron microprobe (EMX) analyses to determine the morphology and identity of the carbides. The most significant metallographic development in this work has been the utilization of backscattered electron (BSE) images from the SEM to obtain positive correlations between the various analytical techniques. The sensitivity of BSE images to chemical composition permits carbides of different compositions to be easily distinguished. BSE images of extracted carbides also permitted positive correlations between XRD, SEM, and EMX results. Stereoscopic examinations of the extracted carbides also provided a routine technique for determining the true morphology of the carbides. The results for specimens examined by these techniques are presented. (auth)

58400 MICRORADIOGRAPHIC STUDY OF FRACTURE IN BORON FILAMENT–ALUMINUM MATRIX COMPOSITE. Steele, J. H. Jr. (Virginia Polytechnic Inst., Blacksburg). pp 159-66 of Proceedings of the Third Annual Technical Meeting of the International Metallographic Society, Inc. /Johnson, K. A. (ed.). Los Alamos, N. Mex.; International Metallographic Society, Inc. (1971).

From third meeting of the International Metallographic Society; Cleveland, Ohio (16 Nov 1970).

A microstructural evaluation of fracture in unidirectional, continuous monolayer and bilayer boron filament–aluminum matrix composite was conducted using microradiography. Samples of the composite sheet were stressed in tension, and acoustic monitoring utilized to detect filament failure. Microradiographs were obtained with the samples maintained at constant elongation after filament damage was detected. This provided in-situ observation of filament failure within the composite. Samples with pre-induced cracks were tested and found to exhibit a filament break propagation mode of composite fracture. This failure mode which is characterized by fan-shaped fragmentation patterns was also observed for transverse fracture. Scanning electron micrographs indicated filament fragmentation with tensile shear behavior in the aluminum matrix. Frequency spectra obtained on typical acoustic emission data tend to indicate that transient resonant vibrations of the gage section are induced by filament fracture. The microstructural observations are discussed in terms of a filament break propagation mode of composite failure in this material. (auth)

58401 NEW PHASES IN THE Sc–V–O SYSTEM. Mikhailov, Yu. Ya.; Pokrovskii, B. I.; Komissarova, L. N. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 198: No. 2, 344-6(11 May 1971). (In Russian).

The results are presented for a phase equilibrium study at 1,000 to 1,500°C in portions of the Sc–V–O system and plotted on the bases of the oxides of Sc (3+), and V (3+, 4+). Only solid solutions are formed by the system Sc_2O_3–V_2O_3; the solubility of scandia in V_2O_3 is 5 mole % Sc_2O_3 at 1,000°C. Between the solid solutions lies a two-phase region which is reduced in size at 1,500°C, being bounded by the compositions 44 and 14 mole % Sc_2O_3. The compound Sc_2VO_5 was noted and the parameters of the elementary cell were measured: a = 6.854, c = 14.572, and z = 8; the pycnometric density was 4.10 g/cm^3. Several analogies to other systems are discussed. (K.S.W.)

58402 LATTICE PARAMETER AND DENSITY OF ZIRCONIUM HYDRIDE PHASE. Paetz, Peter; Luecke, Kurt (Interatom, Bensberg, Ger. Technische Hochschule, Aachen). Z. Metallk.; 62: No. 9, 662-4(Sep 1971). (In German).

The lattice constants of the three zirconium hydride phases given in the literature were investigated. According to the results, the supposition appears to be justified that only one single phase occurs whose lattice parameter varies continuously. The space diagonal assumes the significance of an invariant quantity. The density values determined from the lattice parameters agree well with the results of direct measurements. The dependence of the density on the hydrogen content exhibits kink points which delineate the phase fields of the zirconium-hydrogen system. (auth)

58403 TEXTURE PARAMETERS BY OPTICAL AND ELECTRON-MICROSCOPE PICTURES OF WC-, Co-, TiC-, AND TaC-

ALLOYS. Mader, W.; Mueller, K. F. Radex Rundsch.; No. 4, 286-96(Oct 1970). (In German).

For the examination of complex crystal structures a special etching method was developed. Texture parameters from optical and electron-microscope pictures were compared. Investigations were carried out into the relationships between the physical properties and the texture characteristics. (Metals Abstr.)

58404 CRYSTAL STRUCTURE OF GRAPHITE BROMINE LAMELLAR COMPOUNDS. Sasa, T.; Takahashi, Y.; Mukaibo, T. (Tokyo Univ.). Carbon; 9: No. 4, 407-15(Aug 1971).

The isotherm of bromine on pyrolytic graphite was studied at 20°C by stepwise bromination, and several phases of graphite bromide were identified, which had compositions of C_8Br, $C_{12}Br$, $C_{16}Br$, and $C_{20}Br$. X-ray studies showed that these possessed the socalled 2nd, 3rd, 4th, and 5th stage structures respectively. At bromine concentrations between these definite compositions, x-ray diffraction patterns showed mixtures of the higher stage and the lower stage structures. The density of the intercalated bromine molecules in a layer was believed to stay unchanged with the change of the composition. During the course of the reaction with the saturated vapor of bromine, an intermediate metastable lamellar compound structure was found in which the bromine layers were intercalated into every second layer spacing but for which the bromine concentration was believed to be much lower than that of C_8Br. (auth)

58405 PHASE EQUILIBRIA IN THE SYSTEM $BaO-CeO_2$. Guha, J. P.; Kolar, D. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). J. Mater. Sci.; 6: No. 9, 1174-7(Sep 1971).

The phase equilibrium relationships in the binary system $BaO-CeO_2$ were investigated by thermal analysis, metallographic, and x-ray diffraction methods. The system is characterized by the existence of only one compound, namely, $BeCeO_3$ which is found to melt incongruently at 1480 ± 5°C with formation of solid CeO_2 and a liquid. A eutectic was found to occur between BaO and $BaCeO_3$ at 46 ± 0.5 mole % CeO_2 and its melting point was determined as 1440 ± 5°C. A narrow solid solubility range of BaO in $BaCeO_3$ exists, but no solid solubility of $BaCeO_3$ in either BaO or CeO_2 was detected. (auth)

58406 V–VO PHASE SYSTEM. Alexander, D. G.; Carlson, O. N. (Ames Lab., Iowa). Met. Trans.; 2: No. 10, 2805-11 (Oct 1971).

A phase diagram is proposed for the V–VO system based on melting point determinations, differential thermal analyses, metallographic observations, and x-ray parametric measurements. A eutectic reaction occurs at 1640°C and 29 at.% O. The intermediate phases V_9O and V_2O form peritectoidally at 510 and 1185°C, respectively, while V_4O forms by a peritectic reaction at 1665°C. The VO phase melts congruently at 1790°C. The terminal solubility of oxygen in vanadium increases from 3.2 at.% at room temperature to a maximum of 17.0 at.% at the peritectic temperature. There is also extensive solid solubility associated with each of the intermediate phases. Two martensite-like phases form in alloys in the composition range 6 to 9 at.% O upon quenching from above the 510°C peritectoid horizontal. (auth)

58407 ELECTRON MICROSCOPY OF HYDRIDE PRECIPITATION IN VANADIUM. Chiba, Toshinobu; Takano, Shigeo (Hokkaido Univ., Sapporo. Tokyo Univ.). J. Phys. Soc. Jap.; 31: No. 4, 1113-23(Oct 1971).

Precipitation of hydride from the solid solution of vanadium–hydrogen containing a small amount of hydrogen was observed at temperatures ranging between 300 and 77°K using the cold stage of a 500 kV electron microscope. Two types of precipitates were found at low temperatures. One has a cubic superstructure with a unit cell twice as large as that of vanadium matrix. The other has a tetragonal structure in which vanadium atoms form a body-centered tetragonal lattice with $c/a = 1.1$ to 1.3. On heating, these precipitates dissolved to the matrix at certain temperatures depending on the hydrogen concentration of the specimens. These facts give a direct confirmation to the postulation that the "anomalies" in vanadium metal are caused by the precipitation as the hydride phase of a trace of hydrogen involved. (auth)

58408 CONTRIBUTION TO THE EFFECT OF GAS PRESSURE IN PORES ON BOUNDARY MIGRATION AND GRAIN GROWTH IN SINTERED UO_2. Stevanovic, M.; Petrovic, V. Powder Met. Int.; 2: No. 2, 36-9(Jun 1970).

An investigation of the role of gas pressure in the retarding effect of pores on boundary migration and grain growth was carried out with specimens of sintered UO_2, obtained from green pellets to which different amounts of binder were added, and which were presintered in an atmosphere of H or CO_2. The specimens with different degrees of porosity, C content and different quantities of gases (products of C oxidation) in the pores, were heat treated between 1650 and 1800°C in He. An examination of microstructure and grain growth was conducted. (Metals Abstr.)

58409 THREE PHASE REGION IN TERNARY SYSTEM $UO_2-PuO_2-Pu_2O_3$. Fukushima, Susumu; Sasayama, Tatsuo; Kurihara, Masayoshi; Shimokawa, Junichi (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: No. 9, 534-5 (Sep 1971).

Phases observed in the $(U,Pu)O_{2-x}$ region containing Pu concentrations above 50% at room temperature are described. A constancy in the composition of phases found in this system is the basis for a model which substantiates a ternary $UO_2-PuO_2-Pu_2O_3$ structure. (J.R.D.)

Radiation Effects

Refer also to abstracts 59147, 59148, and 59174.

58410 (BLG–456) GBR FUEL PIN TECHNOLOGY. Asbroeck, Van; Yellowlees, J. M. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). May 1971. 35p. (CONF-710326–2). Dep. NTIS (U. S. Sales Only).

From third meeting on fuel and materials; Brussels, Belgium (18 Mar 1971).

The Brussels Study Group of the Gas Breeder Reactor Association was given the task of performing a design study of a helium-cooled breeder reactor of 1000 MW(e) output. The fuel specification was to be based on mixed oxides of plutonium and uranium fabricated in the form of stainless steel clad fuel pins. The dimensional and mechanical stability of these fuel pins depends on fuel and clad properties which may be affected by a helium-cooled fast reactor environment. In order to make a choice of materials and to set down their properties for design purposes, the following items have received consideration: fuel swelling, fuel melting, fission gas release, fuel and gap conductivity, clad resistance to deformation, ductility, irradiation-induced swelling of stainless steel, and corrosion by helium or by fuel. Results of the study are the basis for fuel characteristics selection as follows: bulk density ≤ 90% theoretical density, diametral clad gap ≥ 2%, fuel swelling rate 0.5 to 0.7 volume percent per 10,000 MWd/te., AISI 316 L with an end-of-life ductility of 0.1% and an assumed maximum swelling of 9 volume per cent (for a fuel peak burn-up and fluence of 100,000 MWd/te 2×10^{23} n/cm^2 respectively). The low carbon version (AISI 316 L) is preferred to the standard alloy (AISI 316) since the former appears to have better resistance to corrosion by moist helium. As regards fuel/clad corrosion the reaction depth may be as high as 100μm at 700°C at the end-of-life. (auth)

58411 (GEAP–12217) FISSION GAS RE-SOLUTION RATES. Quarterly Report No. 4, April 1–June 30, 1971. Marlowe, M. O. (General Electric Co., Pleasanton, Calif. Vallecitos Nuclear Center). Jul 1971. Contract AT(04-3)-189. 8p. Dep. NTIS.

Progress in experimental programs and studies to determine the re-solution rates of fission gases in oxide nuclear fuels under irradiation are described. An intermediate specimen thinning technique with abrasive blasting was developed for use with the radioactive specimens. Three as-irradiated specimens were thinned by the abrasive blasting technique followed by ion milling in preparation for transmission electron microscopy. Five irradiated specimens were annealed at temperatures in the range 1300 to 1600°C. These specimens were pre-thinned to approximately 100 μm thick by metallographic polishing. (auth)

58412 MOBILITY AND PRECIPITATION OF RARE GASES IN SOLIDS DURING ANNEALING FOLLOWING ION BOMBARDMENT. Matzke, Hj. (European Inst. for Transuranium Elements, Karlsruhe, Ger.). pp 326-53 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

The available results on the mobility and precipitation of heavy inert gases (Ar, Kr, Xe, Rn) in solids are summarized and interpreted, using the recently established system of stages. Most studies have been performed on ionic crystals, but some ceramics (mainly nuclear materials, UO_2 and UC) and metals were investigated as well. The system of stages groups gas release processes in order of increasing temperature. The main components are: release of gas fortuitously located on high mobility sites; release of gas connected to annealing of gross structural damage, the most common form of which is bombardment-induced amorphousness; volume diffusion of single gas atoms; temporary

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trapping of gas due to weak gas–gas or gas–damage interactions; strong gas–gas or gas–damage interactions and formation of gas-filled bubbles. Examples for all these stages and substages are given and empirical correlations for the relative importance, the temperatures for onset, and the activation enthalpies of the various stages are deduced. As far as possible, the atomic mechanism of rare gas mobility is described. Some still open questions and existing discrepancies are pointed out and suggestions are made for further work. 48 references. (auth)

58413 APPLICATION OF THE ION BOMBARDMENT TECHNIQUE TO STUDY THE BEHAVIOR OF RARE GASES IN UO_2. Matzke, Hj. (European Inst. for Transuranium Elements, Karlsruhe, Ger.). pp 354-91 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

The system of stages in gas release is used to predict the behavior and the mobility of fission rare gases in UO_2. The predictions are compared with literature data and with new experimental results. Stage IA is observed as expected as a fast release process at low temperatures, most probably involving release of gas situated in surface near atom layers. Stage IB release is predicted to be absent in UO_2, since due to the low recrystallization temperature of amorphous UO_2, no gross structural damage survives ion bombardment or reactor irradiation performed at or above room temperature. Ion bombardment work shows that Stages IIA and IIB due to mobility of the gas at the temperatures of self-diffusion yield, as expected, activation enthalpies of about 3.9 and 4.5 eV, respectively, the latter value being close to the most probable result for uranium self-diffusion (4.5 to 4.8 eV). Comparison is made with the extensive literature on reactor-irradiated UO_2. The most probable mechanism of Stage IIA, the diffusion of single gas atoms in virtually undamaged UO_2, is confirmed to be via Schottky trios, i.e., molecular voids in UO_2, by studying gas mobility in $UO_{2\pm x}$. Stage III, or the behavior of gas-filled bubbles, is discussed on the basis of results obtained both on ion-bombarded and reactor-irradiated UO_2, and the basic differences between laboratory annealing and in-pile annealing on the mobility of bubbles are given. (auth)

58414 URANIUM DIOXIDE FUEL PIN ELONGATION BEHAVIOR UNDER IRRADIATION. Ichikawa, Michio; Uchida, Masaaki; Morishima, Atsuyoshi; Taketani, Kiyoaki (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: No. 9, 528-30(Sep 1971).

Results of irradiation experiments in which the effects of burnup and pellet-clad clearances on the behavior of fuel pins are discussed. The effects of original pellet-clad clearance do not appear simultaneously after initiation of irradiation. With increasing burnup of the fuel, the heat rating necessary for the occurrence of pellet-clad interaction is lower. The permanent residual elongation of the pin increases linearly with burnup. (J.R.D.)

Plastics and Other Materials

Refer also to abstracts 57614, 57625, and 59161.

58415 (FRNC-TH-61) DEFORMATION AND ULTIMATE STRENGTH OF A CONCRETE UNDER TRIAXIAL STRESS. Gachon, Herve (Paris Univ. (France). Faculte des Sciences). 5 May 1970. 62p. (In French). Dep. NTIS (U. S. Sales Only). Thesis.

The deformation and the ultimate strength of a prestressed concrete used in reactor vessels were studied. A machine for the triaxial stressing of concretes was developed. In the study of concrete deformation under a slow stress of short duration, three characteristic thresholds are observed: a reversibility threshold, a dislocation threshold and an ultimate strength threshold; this last threshold was studied in detail. (France)

58416 (RLO-2098-2) POLYMER GRAFTING TO INORGANIC SUBSTRATES. Annual Report, February 1, 1970–January 31, 1971. Raff, R. A. V.; Subramanian, R. V.; Schecter, D. J.; Adams, M. F. (Washington State Univ., Pullman. Research Div.). 31 Jan 1971. Contract AT(45-1)-2098. 64p. Dep. NTIS.

The effect of gamma radiation on a few polymer composites and on two metal–epoxy resin systems was studied. Considerable improvement in mechanical properties and increased creep resistance were observed in irradiated polymer composites of high or low density polyethylenes with long or short glass fiber, aluminum oxide, carbon black, silica, silica gel, sodium aluminosilicate, magnesium oxide, or calcium carbonate. Gamma radiation in the dose range 10^7 to 10^8 rads caused only deterioration in the strengths of specimens made from polystyrene, polystyrene–carbon black blends, polysulfone or polysulfone–glass fiber blends. The strength of joints of stainless steel to epoxy resin was found to be tripled after exposure to 6.0×10^7 rads. Similar results were observed with copper. (D.H.M.)

58417 GAMMA RAY-INDUCED DISORIENTATION OF POLYMER MOLECULES. Korodenko, G. D.; Karimov, S. N. (Tadzhik State Univ., Stalinabad, USSR). Dokl. Akad. Nauk Tadzh. SSR; 14: No. 3, 21-4(1971). (In Russian).

Oriented macromolecules were prepared by stretching polyvinyl alcohol samples at 120°C to 430%, and polyethylene samples to 900%. Infrared spectra and studies of dichroism showed that gamma-irradiated polymers developed network structures which opposed orientation. Radiation caused crosslinking in polyethylene resulting in a reduction of the intermolecular distance from 3 Å to 1.54 Å and disorientation of the polymer chains. (K.S.W.)

58418 $TlF–UF_4$ SYSTEM. Avignant, Daniel; Cousseins, J. C. (Univ., Clermont-Ferrand, France). Compt. Rend., Ser. C; 272: No. 26, 2151-3(28 Jun 1971). (In French).

The study of the $TlF-UF_4$ system by differential thermal analysis and x-ray crystallography led to the determination of the characteristics of the following phases: two polymorphic forms of Tl_4UF_8 and Tl_3UF_7, and two polymorphic forms of Tl_2UF_6 and $Tl_7U_6F_{31}$, $TlUF_5$, TlU_3F_{13}, and TlU_6F_{25}. The crystallographic characteristics of four of these phases were investigated: Tl_3UF_7 is cubic; Tl_2UF_6 at low temperatures is orthorhombic; and $Tl_7U_6F_{31}$ is rhombohedral; and TlU_6F_{25} is hexagonal. (France)

58419 RADIATION DAMAGE TO THE CRYSTALLINE STRUCTURE OF A GLASS-FORMING CHALCOGENIDE. Chen, C. W.; Bailey, D. M. (Ames Lab., Iowa). Radiat. Eff.; 10: No. 1-2, 65-9(Jul 1971).

Crystalline samples of a glass-forming chalcogenide, $As_{0.50}Te_{0.42}Ge_{0.08}$, have been irradiated by fast neutrons to the fluence of 3.4×10^{18} n/cm^{-2} (E > 1 MeV) at 83°K. X-ray diffraction examination indicated that such irradiation substantially destroys the crystalline structure. A recovery process was observed to occur at room temperature. However, 270 days after irradiation, the originally crystalline structure still remained severely damaged. The material appeared to be more susceptible to radiation damage than other solids at low temperatures. (auth)

58420 RADIATSIONNAYA STOIKOST' LAKOKRASOCHNYKH POKRYTII. (Radiation Stability of Lacquer Coatings). Knyazev, V. K. Moscow; Atomizdat (1971). 184p.

The use of lacquer coatings as a protective agent in industrial equipment and construction is discussed. The central theme, however, is the radiolysis of such films. Radiation-induced changes in polymeric materials are examined from several points of view: mechanical, physicochemical, and electrical. The sorption–desorption properties of coatings, and the practical use of lacquers in radiation fields and in the presence of radioactive contamination are considered. 202 references. (tr-auth)

58421 GLASS FOR NUCLEAR RESEARCH AND ENGINEERING. Kerntech. Atomprax.; 13: No. 7-8, 345-7(Jul-Aug 1971). (In German).

Glasses for nuclear research and engineering are discussed. Information is presented on the physical characteristics of specific types of glass used for radiation shielding, the equivalent lead thickness of glasses for shielding against radiation from a ^{60}Co source, the design and performance of composite glass windows for hot cells, glasses for dosimeters, and the use of glass pipes in reactors. (L.C.L.)

58422 ADVANCED COMPOSITE MATERIALS IN SPACECRAFT. Forest, J. D. Mod. Plast.; 47: No. 9, 136-7; 140 (Sep 1970).

Composite materials of B or graphite continuous filaments in a resin or metal matrix are promising for space vehicle applications such as cryogenic tankage, missile support systems, and antennas. Major advantages are the high strength and stiffness at low weight, the very low thermal distortion, and large weight savings. A table lists density, thermal-expansion coefficient, longitudinal and transverse tensile strength, and shear strength values for composites with epoxy or Al matrices. (Metals Abstr.)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 59097, 59359, 59596, and 59733.

Cosmic Ray Exposure Ages

58423 DISTRIBUTION OF TOTAL NITROGEN IN IRON METEORITES. Gibson, Everett K. Jr.; Moore, Carleton B. (Arizona State Univ., Tempe). Geochim. Cosmochim. Acta; 35: No. 9, 877-90(Sep 1971).

Total nitrogen abundances in 123 iron meteorites were determined by inert carrier–gas fusion extraction–gas chromatography. The median value for the iron meteorites was found to be 18 ppm N. The N contents of sulfide inclusions are greater, in nine cases out of ten, than the corresponding metallic phase. The N content of the iron meteorites is positively correlated with germanium content. The effects of terrestrial weathering and heat treatment by man are discussed in relation to the N contents measured for certain specimens. A correlation between N and cooling rates was found, with lower cooling rates associated with greater N abundances. (auth)

Stars

Refer also to abstracts 58849, 58855, 59041, 59585, and 59866.

58424 NEUTRON STARS IN BINARY SYSTEMS SHOULD NOT BE PULSARS. Shvartsman, V. F. (Shternberg Astronomical Inst., Moscow. Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 342-3(Sep-Oct 1971).
Translated from Astron. Zh.; 48: No. 2, 438-40(Mar-Apr 1971).

Even a weak stellar wind from the normal component of a binary system would be capable of suppressing the ejection of material from a neutron-star component. Hence, neutron stars in binary systems could appear as pulsars only for a comparatively short time until the ejection has been replaced by accretion of material from the normal component. The pulsar would decay and an x-ray source would probably develop in its place. (auth)

58425 STABILITY OF A STAR WITH A PHASE CHANGE IN GENERAL RELATIVITY THEORY. Seidov, Z. F. (Shemakha Astrophysical Observatory, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 347-8(Sep-Oct 1971).
Translated from Astron. Zh.; 48: No. 2, 443-5(Mar-Apr 1971).

On the basis of general relativity theory the critical value was found for the discrete change $q = \epsilon_2/\epsilon_1 = 3/2\,(1 + P_0/\epsilon_1)$ in the energy density (P_0 is the pressure at the phase transition) that would lead, through a phase change, to the loss of a star's stability at the point where the central pressure $P_c = P_0$. (auth)

58426 HYDROGEN LINES IN ENVELOPE OF NOVA HERCULIS 1934. Antipova, L. I. (Astronomical Council, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 225-31(Sep-Oct 1971).
Translated from Astron. Zh.; 48: No. 2, 288-95(Mar-Apr 1971).

Possible mechanisms for the formation of the hydrogen absorption lines in the envelope of Nova Herculis 1934 (DQ Her) are discussed. It is found that the hydrogen absorption lines in the premaximum spectrum (at maximum light) and in the principal spectrum (after maximum) are broadened by the Stark effect. The principle of an optically thin layer yields the number of hydrogen atoms in the second quantum state along the line of sight, log $N_{0,2}H$, at the epoch when the premaximum spectrum was replaced by the principal spectrum. An estimate is obtained for the number $(N_{0,2}H)_{tot}$ of hydrogen atoms in the entire envelope at each epoch considered. These numbers are equal, affording direct support for Mustel's model, according to which the envelope detached from the star immediately after maximum light experiences a contraction. A comparison of the electron concentrations determined for the different dates further supports this conclusion. (auth)

58427 SIMPLE METHOD FOR DETERMINING PHOTOMETRIC ORBITAL ELEMENTS. Lavrov, M. I. (Kazan State Univ.). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 236-41(Sep-Oct 1971).
Translated from Astron. Zh.; 48: No. 2, 301-8(Mar-Apr 1971).

A new method for determining the photometric orbital elements of eclipsing binaries is proposed and tested successfully on the light curves of MN Cas, XZ Per, and FK Aql. The method has all the advantages attributed to the Kopal and Kopal–Piotrowski methods, but differs from them in its noteworthy simplicity for formulating and solving the basic equations. (auth)

58428 PURELY DISCONTINUOUS RANDOM PROCESSES IN AN IRREGULAR FORCE FIELD. III. VELOCITY VARIATION OF A STAR IN A QUASI-STATIONARY SPHERICAL CLUSTER. Petrovskaya, I. V. (Leningrad State Univ.). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 242-6(Sep-Oct 1971).
Translated from Astron. Zh.; 48: No. 2, 309-15(Mar-Apr 1971).

The second Kolmogorov–Feller equation is used to describe the evolution of the velocity distribution function of a star group in a quasi-stationary spherical system. The velocity distribution function of the field stars is assumed to vary homologously with time. The regular potential of the cluster is neglected. For a typical open cluster the time required for total dispersal is found to be $t = 31\,\tau_0$, where τ_0 is the relaxation time of the cluster at $t = 0$. The velocity distribution function, the proportion of stars evaporating (escape rate), and the proportion of energy removed by them are evaluated for the star group in question at different epochs. (auth)

58429 DENSITY DISTRIBUTION OF BRIGHT STARS IN THE GLOBULAR CLUSTER M56. Kholopov, P. N. (Shternberg Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 247-9(Sep-Oct 1971).
Translated from Astron. Zh.; 48: No. 2, 316-19(Mar-Apr 1971).

Star counts to 16.7m pg demonstrate that the radius of the bright-star subsystem in the cluster M56 is 7.2, and the radius of the central nucleus zone is 0.9 pc. The logarithmic density range of this subsystem, $D_f = 3.5$, is nearly the same as the value for the subsystem of bright stars of constant luminosity in the cluster NGC 5466. (auth)

58430 STABILITY OF GLOBULAR CLUSTERS AND SPHERICAL GALAXIES. Fridman, A. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 250-2(Sep-Oct 1971).
Translated from Astron. Zh.; 48: No. 2, 320-2(Mar-Apr 1971).

A globular star cluster (or spherical galaxy) is modeled by a spherically symmetric system of rotating, gravitating masses. In accordance with observational evidence an r^{-2} density profile is adopted, with particle trajectories such that the total momentum of the system vanishes. The stability of such a model against arbitrary perturbations has been demonstrated on the basis of results from plasma physics; rigorous mathematical proofs of stability have been given elsewhere. (auth)

58431 POSSIBILITY OF A PULSED MASS OUTFLOW FROM A ROTATING MAGNETIC STAR. Ozernoi, L. M.; Usov, V. V. (Lebedev Inst. of Physics, Moscow. Moscow Technical Physical Inst.). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 187-9(Sep-Oct 1971).
Translated from Astron. Zh.; 48: No. 2, 240-3(Mar-Apr 1971).

The competition between two mechanisms of angular-momentum loss for a rotating magnetic star, deceleration due to stretching of the magnetic lines of force and mass outflow due to rotational instability, can under certain conditions result in an outflow of pulsed character. (auth)

58432 ULTRADENSE MATTER. Frautschi, S.; Bahcall, J. N.; Steigman, G.; Wheeler, J. C. (California Inst. of Tech., Pasadena). Comments Astrophys. Space Phys.; 3: No. 4, 121-6(Jul-Aug 1971).

It has recently been hypothesized that, beyond the low density region where present knowledge of nuclear forces suffices and the intermediate density region where present knowledge of forces among nucleons and light baryons is inadequate, there lies a third ultradense region where heavier baryons dominate and the description becomes simpler again. Two assumptions made in connection with this hypothesis are supported by three arguments and the Hagedorn level density is considered. (W.D.M.)

58433 LUMINOSITY OF HIGH-TEMPERATURE STARS. Cattani, M.; Fernandes, N. C.; Osada, J. (Univ., Sao Paulo, Brazil). An. Acad. Brasil. Cienc.; 42: No. 4, 677-8(Dec 1970).

Although the luminosity of normal stars has been extensively studied, there is no detailed work on the luminosity of very high-temperature stars, except for a simple order of magnitude estimate by Chin (1964). Since this problem is related to the problem of neutron stars, it is studied in some detail. (W.D.M.)

58434 PULSATIONS OF MASSIVE MAIN-SEQUENCE STARS. Clayton, D. D. (Rice Univ., Houston, Tex.). Comments Astrophys. Space Phys.; 3: No. 4, 127-31(Jul-Aug 1971).

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Developments in the evolution, stability, dynamics, and pulsation mechanisms in massive main-sequence stars are reviewed. The relation of helium in the early stages of the Galaxy to these massive stars is discussed. (W.D.M.)

58435 TWO NEW CHAPTERS IN THE STORY OF U CEPHEI. II. Batten, Alan H. (Dominion Astrophysical Observatory, Ottawa); Plavec, Miroslav. Sky Telesc.; 42: No. 4, 213-15(Oct 1971).

New spectroscopic results indicate that a substantial quantity of dimly glowing gas is present in the space between the components of this eclipsing binary, particularly near the B6V star. This supports the conclusion, drawn from study of the period changes and from early spectroscopic work, that mass is being transferred from the G secondary to the B primary. (W.D.M.)

58436 STUDY OF THE BALMER ABSORPTION LINES OF NOVA HERCULIS 1963. Friedjung, M. (Institut d'Astrophysique, Paris). Astron. Astrophys.; 14: No. 2, 246-51(Sep 1971).

A study of line profiles of some spectra of Nova Herculis 1963 has led to demonstrations of the occurrence of inhomogeneities, and the importance of the ionization produced by the absorption of Balmer continuum quanta. (auth)

58437 IMPROVED METHOD FOR COMPUTING MEMBERSHIP PROBABILITIES IN OPEN CLUSTERS. Sanders, W. L. (Univ. of Chicago, Williams Bay, Wis.). Astron. Astrophys.; 14: No. 2, 226-32(Sep 1971).

Relative proper motions in the region of open clusters are fitted to a model by a maximum likelihood procedure for determining the frequency distribution function parameters for field and cluster stars. The clusters NGC 2168, 2281, 2420, 6633, 6823 and 7062 were re-examined for membership. (auth)

58438 SPECTRAL SYNTHESIS OF LOW-DISPERSION LUMINOSITY CRITERIA IN A- AND F-TYPE STARS. Bolton, C. T. (Univ. of Michigan, Ann Arbor). Astron. Astrophys.; 14: No. 2, 233-42(Sep 1971).

Synthetic spectra were computed for three regions, 4172-78 Å, 4417 Å, and 4481 Å, used for the luminosity classification of A and F stars on low-dispersion spectra. The ratio $\lambda4178:\lambda4172$ was found to be well correlated with surface gravity for stars with solar abundances. In the LTE approximation used the ratio $\lambda4417:\lambda4481$ was found to be at least as sensitive to microturbulence as it is to surface gravity. The NTE interpretation of this result is also discussed. Qualitatively, the behavior of these features in Am spectra are duplicated best by a model with $\log g = 4.3$, and abnormal abundances like those found by van't Veer–Menneret and Conti for 63 Tauri and the same microturbulence as in stars with solar abundances. The "anomalous luminosity effect" in Am stars between the ratios $\lambda4178:\lambda4172$ and $\lambda4417:\lambda4481$ is attributed to the abundance of iron and chromium being enhanced more in Am stars than the abundance of titanium. The consequences for spectral classification of possible variations of abundances and microturbulence at a given effective temperature and surface gravity are discussed. This investigation demonstrates that, even with the present limited knowledge of the values and ranges of such parameters as microturbulence and abundances as functions of effective temperature and surface gravity, spectral classification is a very powerful tool for studying stellar atmospheres. (auth)

58439 STELLAR GROUPS Ba 8, Ba 9, AND Be 68. Wagner, R. (Univ., Basel). Astron. Astrophys.; 14: No. 2, 283-92(Sep 1971).

Three-color photometry of these three stellar groups in the RGU system on plates taken with the 48-inch Palomar-Schmidt leads to the conclusion that they are physical groups at distances of 1320 pc, 5520 pc, and 3160 pc, respectively. The earliest color types are as follows: b 2 in Ba 9, a 0 in Ba 8, and b 8 in Be 68. Ba 8 and Be 68 include a red-giant branch. (auth)

58440 COMMENTS ON THE INSTABILITY STRIP FOR HALO POPULATION VARIABLES. Iben, Icko Jr.; Huchra, John (Massachusetts Inst. of Tech., Cambridge). Astron. Astrophys.; 14: No. 2, 293-310(Sep 1971).

Results of pulsation calculations in the linear, nonadiabatic approximation are presented. Major emphasis is placed on the location in the H–R diagram of the blue edges of the theoretical instability strip for pulsation in the first harmonic mode and in the fundamental mode. For a given composition, the luminosity and the period of the fundamental at the intersection of these two blue edges increase with increasing stellar mass. The slope of the relationship between period and luminosity defined by intersection points is similar to the slope of a transition curve that results from nonlinear calculations and has been used to estimate the absolute luminosity of RR Lyrae stars in globular clusters. It is suggested that the two curves are related. Pulsation results are compared with the observations and with the results of stellar evolution calculations in an effort to test this suggestion. (auth)

58441 SECOND-ORDER ROTATIONAL PERTURBATION OF NONRADIAL OSCILLATIONS OF A STAR. Smeyers, P.; Denis, J. (Katolicke Univ., Louvain, Belgium). Astron. Astrophys.; 14: No. 2, 311-18(Sep 1971).

The perturbation method is applied for the effects of a uniform rotation on nonradial oscillations of a star, up to the second order in the angular velocity. The distortion of the equilibrium configuration is taken into account by means of a transformation into spherical coordinates defined in a reference sphere and by means of a parallel displacement of the displacement vector, from the points of the spheroid into the points of the reference sphere. Numerical results obtained for a rotating homogeneous and compressible spheroid agree with values already known from other methods. The stabilizing effect of a slow uniform rotation on convection is corroborated. (auth)

58442 ORBITAL ELEMENTS OF THE SPECTROSCOPIC BINARIES HD 24733 AND HD 861. Acker, A. (Univ., Strasbourg). Astron. Astrophys.; 14: No. 2, 189-97(Sep 1971).

The radial velocity curve was determined for the spectroscopic binary HD 24733 from 97 observations made with the spectrograph C (telescope 120 cm O. H. P.) in September 1969 and January 1970. The orbital elements of HD 861 were determined from 14 observations made between 1968 and 1969, and 3 observations made in 1954 by Boulon. (W.D.M.)

58443 SPORADIC OUTBURSTS OF RED-DWARF STARS. Lovell, Bernard. Quart. J. Roy. Astron. Soc.; 12: No. 2, 98-132(Jun 1971).

This Presidential address was delivered on Feb. 12, 1971 under the following headings: flare stars; radio observations of the flares; spectral characteristics; light and radio emission curves of the flares; flare-star contribution to the galactic radio emission; energy of the out bursts; evolution of red-dwarf flare stars; theoretical considerations concerning the outbursts; and production of x rays and cosmic rays from flares. In conclusion it is suggested that these stars may be worthy of more attention than their inconspicuous nature suggests. They are truly stars in the early processes of birth; they are violently active in the optical and radio domains; they have stellar winds that contribute significantly to the interstellar medium; their integrated x-ray fluxes probably contribute a few percent of the total observed x-ray flux and may well be dominant in highly obscured regions like Taurus; and they are probably the source of very-energetic cosmic-ray protons. (51 references) (UK)

58444 CNES AND SPACE ASTRONOMY. Blamont, J. E. (Centre National d'Etudes Spatiales, Paris). Rech. Spatial.; 10: No. 3, 1-5(May 1971). (In French).

The various fields of space astronomy studied by the CNES are briefly discussed and the experiments performed are reviewed. (France)

58445 STELLAR ULTRAVIOLET AND UV STARS. Gaide, Albert (European Space Research Organization, Paris). Rech. Spatial.; 10: No. 3, 8-10(May 1971). (In French).

The wavelength range of interest in uv astronomy is recalled and the results obtained in this range are briefly mentioned. (France)

58446 REDUCED HELIUM ABUNDANCES IN NEBULAE. Robbins, R. R. (Univ. of Texas, Austin); Daltabuit, E.; Cox, D. P. Astrophys. J.; 169: No. 2, L77-81(15 Oct 1971).

Recent capture-cascade calculations by Robbins and Robinson for the helium singlets, and also calculations by Cox and Daltabuit concerning collisional excitation in the helium triplets, imply a reduction in nebular helium abundances. For planetary nebulae, $\langle He/H \rangle \sim 0.081 \pm 0.03$ from singlet lines and 0.093 ± 0.02 from triplet lines, if all published data are used. Selecting the three best observed nebulae only, one finds $\langle He/H \rangle \sim 0.092 \pm 0.015$. For the Orion nebula, He/H ranges from 0.064 to 0.081 for various regions of the nebula. Some consequences of these reductions are discussed. (auth)

58447 SPECTRA OF WHITE DWARFS WITH CIRCULAR POLARIZATION. Greenstein, Jesse L.; Gunn, James E.; Kristian, Jerome (California Inst. of Tech., Pasadena). Astrophys. J.; 169: No. 2, L63-9(15 Oct 1971).

Spectra of circularly polarized stars, EG 248, GR 289, and EG 250 (Giclas G99–37, G99–47, and G195–19) were examined, together with spectrophotometric scans. It was confirmed that EG 248 has C_2 and CH, GR 289 apparently no features as yet detectable, and EG 250 possibly weak C_2 and, less certainly, shallow depressions (probably metallic lines) in the violet. Their mean absolute magnitudes were estimated to be between +12 and +15. Stars of similar color and luminosity have relatively easily visible lines. It is suggested that circularly polarized degenerate stars are convective, diluting surface hydrogen and bringing unusual elements to the surface from what were cores of old red giants. (auth)

58448 SOLID-STATE ASTROPHYSICS. Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). pp 75-80 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

In certain types of very dense stars the nuclei form a lattice and, in some ways, such a "stellar solid" is simpler to treat than the familiar solids. A short review of this subject is given. (W.D.M.)

58449 SOME RED GIANTS OF THE OLD DISK POPULATION. Eggen, O. J. (Australian National Univ., Canberra). Publ. Astron. Soc. Pac.; 83: No. 494, 423-32(Aug 1971).

(UBVRI) photometry and space motions of several old disk population red stars are presented. These stars include 14 new variables. (auth)

58450 OBSERVATIONS OF THE RECOVERY AND FINAL DECLINE OF NOVA SERPENTIS 1970. Borra, Ermanno F. (Univ. of Western Ontario, London). Publ. Astron. Soc. Pac.; 83: No. 494, 447-8(Aug 1971).

Ten nights of photoelectric observations of Nova Serpentis 1970 are presented. Three spectrograms in the nebular stage were taken. After a small brightening, Nova Serpentis 1970 appears to be declining slowly towards minimum. (auth)

58451 MONOCHROMATIC REFLECTION EFFECT OF CLOSE BINARY STARS. Chen, Kwan-yu (Univ. of Florida, Gainesville); Rhein, Walter J. Publ. Astron. Soc. Pac.; 83: No. 494, 449-58(Aug 1971).

The stars of a binary system are assumed to exchange radiation like spherical black bodies with limb darkening. The temperatures of the facing surfaces are calculated as functions of the radii, the intrinsic temperatures, and the coefficients of limb darkening of the two stars. The light curves, neglecting eclipses, are then calculated as functions of the wavelength of the radiation, the inclination of the system and its phase, using numerical integration on a digital computer. The geometrical model of the system is exact and allows calculations to be made for close binary systems. The orbit is assumed to be circular. Results for several typical close binary systems are shown. Comparisons are made with the light curves of several observed close binaries. (auth)

58452 UBV PHOTOMETRIC STUDY OF HS HERCULIS. Hall, Douglas S.; Hubbard, G. Scott (Vanderbilt Univ., Nashville). Publ. Astron. Soc. Pac.; 83: No. 494, 459-70(Aug 1971).

About 250 new UBV observations are presented. A photometric complication, which causes maximum brightness after secondary minimum to be retarded until about 0.7^p, was observed on two separate nights and was strongest in U. Ignoring $0.5^p < p < 0.7^p$ and assuming $x_s = x_g = 0.6$, the solution $k = 0.55$, $r_g = 0.259$, $j = 88.7°$, and $L_h = 0.900, 0.915, 0.932$ in V, B, U, respectively, was obtained. (B – V) and (U – B), corrected for reflection, implied B4 ± 1 and A4 ± 1 for the primary and secondary, with $E(B - V) = 0.15m$. With the mass function of Cesco and Sahade and the mass–luminosity relation of Iben applied to the hot star, the absolute dimensions $4.7\,\mathfrak{M}_\odot$, $2.8\,R_\odot$ and $1.6\,\mathfrak{M}_\odot$, $1.6\,R_\odot$ for the primary and secondary, respectively, were derived. The orbital period is variable and only apsidal motion, with a period of $15\frac{1}{2}$ years, can explain the available times of minimum and the spectroscopic elements. With HS Herculis detached and with both stars clearly on the main sequence, circumstellar material was not expected and the photometric complication was puzzling. A model is proposed in which a cloud is situated within the Roche lobe of the cool star near the conical point, and it is speculated that such a cloud might be the remains of a disk-like cloud such as surrounds the much younger binary BM Orionis. (auth)

58453 RED RR LYRAE VARIABLE DK VELORUM. Jones, D. H. P. (Australian National Univ., Canberra). Publ. Astron. Soc. Pac.; 83: No. 494, 471-3(Aug 1971).

DK Vel appears to be a short-period, metal-rich variable, cooler than any other RR Lyrae star. (auth)

58454 PHOTOMETRY OF THREE PECULIAR A-TYPE STARS. Morrison, Nancy D.; Wolff, Sidney C. (Univ. of Hawaii, Honolulu). Publ. Astron. Soc. Pac.; 83: No. 494, 474-7(Aug 1971).

Four-color (uvby) photoelectric observations yielded provisional periods for three peculiar A-Type stars. For 108 Aquarii, the period was 3.73d. For HD 184905, the period was either 1.84 or 2.17d, and for θ^1 Microscopii the most probable periods were 0.941 and 1.062d. (auth)

58455 FAINT SUPERNOVA IN AN ANONYMOUS SOUTHERN GALAXY. Van Agt, Steven; Coutts, Christine (Univ. of Toronto). Publ. Astron. Soc. Pac.; 83: No. 494, 478(Aug 1971).

On a series of 11 Curtis Schmidt plates of the Sculptor dwarf galaxy obtained between Aug. 4 and 11, 1970, a supernova was found at $\alpha = 1$ h 1.8 m, $\delta = -35°22.8'$ (1950). It is located in a spiral arm of a faint anonymous galaxy of Type Sc II, 17″ north and 0″ west of the nucleus $m_J = 18.8 \pm 0.4$m.

58456 SUBLUMINOUS B-TYPE STAR CD -42^0 14462. Bond, Howard E.; Landolt, Arlo U. (Louisiana State Univ., Baton Rouge). Publ. Astron. Soc. Pac.; 83: No. 494, 485-7 (Aug 1971).

Observations of the tenth-magnitude, newly discovered peculiar B-type star CD−42°14462 are described. Photometrically this object shows a large ultraviolet excess, and its spectrum contains only broad and shallow absorption lines of H and He I. It may be related to the white-dwarf stars, and certainly it is one of the brightest of the subluminous stars now known. (auth)

58457 UBV OBSERVATIONS OF VISUAL DOUBLE STARS. Lutz, Thomas E. (Washington State Univ., Pullman). Publ. Astron. Soc. Pac.; 83: No. 494, 488-90(Aug 1971).

UBV magnitudes were obtained at Kitt Peak for 28 visual binaries. The magnitudes and color indices are tabulated. (W.D.M.)

58458 FOUR SUSPECTED SPECTROSCOPIC BINARIES IN THE PLEIADES. Pearce, J. A.; Hill, Graham (Dominion Astrophysical Observatory, Ottawa). Publ. Astron. Soc. Pac.; 83: No. 494, 493-5(Aug 1971).

Radial velocities are presented for four suspected spectroscopic binaries in the Pleiades. Published elements are confirmed for one object, yet another may be variable, and two are probably constant velocity objects. (auth)

58459 TECHNETIUM IN THE MIRA VARIABLE RZ PEGASI. Peery, Benjamin F. Jr. (Indiana Univ., Bloomington); Keenan, Philip C.; Marenin, Irene R. Publ. Astron. Soc. Pac.; 83: No. 494, 496(Aug 1971).

Absorption lines of technetium appear in considerable strength in the spectrum of RZ Pegasi (P = 439d) as photographed with the 200-inch coudé spectrograph on Sept. 18, 1970, three weeks after maximum. In the reproduction the positions of the three zero-volt lives of Tc at $\lambda\lambda$ 4238.191, 4262.270, and 4297.098 are indicated. (W.D.M.)

58460 RADIAL VELOCITY OBSERVATIONS OF THE DELTA SCUTI STAR 20 CANUM VENATICORUM. Penfold, J. E. (Univ. of Victoria, B. C.). Publ. Astron. Soc. Pac.; 83: No. 494, 497-501(Aug 1971).

Radial-velocity observations of the Delta Scuti star 20 CVn taken over four nights indicated a probable variable radial velocity with an amplitude of about 1.5 km/sec. An attempt to determine the period resulted in two estimates, viz. 0.135 and 0.176d. The former value appears to fit the data slightly better and is suggested as the true period. Photometric observations in the V band obtained on one of the nights show that maximum light apparently occurs on the rising branch of the velocity curve near minimum velocity. (auth)

58461 HD 21242: A SPECTROSCOPIC BINARY WITH H AND K EMISSION. Carlos, Robert C.; Popper, Daniel M. (Univ. of California, Los Angeles). Publ. Astron. Soc. Pac.; 83: No. 494, 504-7(Aug 1971).

Orbital elements are given for the spectroscopic binary HD 21242, (6.5m, G5V). The period is 6.4d. The cooler component has strong Ca II emission with the same velocities as its absorption lines and is slightly more massive than the G5 star. HD 21242 is a noneclipsing counterpart of a sizable group of eclipsing binaries. (auth)

58462 EVIDENCE FOR PRODUCTS OF RAPID NEUTRON CAPTURE ON THE SURFACES OF PECULIAR A STARS. Kuchowicz, B. (Univ., Warsaw). Astrophys. Lett.; 9: No. 2, 85-9(Sep 1971).

XUM

Observations indicate the presence of the unstable element promethium, as well as of certain products of rapid neutron capture in peculiar A stars. An analysis of these features indicates the possible presence of the heaviest elements (from the hypothetical island of stability around Z = 114) in the surfaces of these stars. Observational results concerning some specific abundance correlations (e.g. between promethium, uranium, and plutonium in the same star) are desirable to prove the hypothesis. (auth)

58463 TRANSFORMATION OF THE STELLAR WIND EQUATIONS. Roberts, P. H. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. Lett.; 9: No. 2, 79-80(Sep 1971).

A simple transformation is demonstrated which reduces the number of parameters in the stellar wind equations from two to one. (auth)

58464 PHOTOMETRIC OBSERVATIONS OF SUPERNOVA 1971 IN NGC 4165. de Vaucouleurs, G.; de Vaucouleurs, A.; Brown, G. S. (Univ. of Texas, Austin). Astrophys. Lett.; 9: No. 2, 77-8(Sep 1971).

UBV photometry of the supernova in NGC 4165 on April 23, 24, 26, and 27, 1971, gives results consistent with a Type I supernova that reached a maximum m = 13.2 ± 0.2 (B) on April 11 ± 2. The total magnitudes and colors of the galaxies measured through an aperture of 2.50 arc min are $V_t = 13.57$, $(B-V)_t = +0.74$, $(U-B)_t = +0.21$. (auth)

58465 MULTIPLICITY OF SOLUTIONS FOR THE EQUILIBRIUM MODELS OF A HELIUM-BURNING POPULATION I STAR. Kozlowski, Maciej (Univ., Warsaw). Astrophys. Lett.; 9: No. 2, 65-7(Sep 1971).

A nonevolutionary sequence of static models for a helium-burning star of 10 $M_\odot$ is constructed. Along this sequence the Vogt-Russell theorem is not valid. For a certain range of helium core masses it is possible to construct three different models of a star with a given total mass and a given chemical structure. These models possess different parameters at the surface but identical parameters at the center. One model is a cool supergiant with a deep convective envelope, the second one has a high effective temperature, and the third lies between them on the H-R diagram. It is suggested that the erratic behavior of the evolutionary tracks computed for models burning helium in the core may be partly due to the existence of multiple solutions of stellar structure equations. (auth)

58466 SEARCH FOR SOUTHERN OH-IR OBJECTS. Caswell, J. L.; Robinson, B. J.; Dickel, Helene R. (CSIRO, Sydney). Astrophys. Lett.; 9: No. 2, 61-4(Sep 1971).

A search was made for 1612-MHz OH emission from 94 long-period variable stars in the southern sky. V Microscopii gave the only positive detection. In addition, a new 1612-MHz emission source (OH338.5 + 0.1) with the characteristics of an OH-ir object was discovered by chance; at this position no long-period variable is known and no ir object has yet been found. (auth)

58467 SOLUTION OF NON-LTE TRANSFER PROBLEMS. Avrett, Eugene H. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 511-29(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

In the outer layers of a stellar atmosphere, the radiation at line and continuum wavelengths strongly influences the relative number of atoms in various states of excitation and ionization. Conversely, the radiation at a given point often depends on the atomic populations throughout a large surrounding region. Therefore, one has a local dependence of n_i on I_v, together with a nonlocal dependence of I_v on values of n_i. Various procedures involving either differential equations or integral equations can be used to solve for either I_v or n_i. The main topic of this review is the integral-equation approach, with emphasis on numerical methods developed in recent years for the solution of physically realistic problems. (auth) (UK)

58468 RADIATIVE TRANSFER IN TWO-COMPONENT STELLAR ATMOSPHERES. Avrett, Eugene H.; Loeser, Rudolf (Smithsonian Astrophysical Observatory, Cambridge, Mass.). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 559-71(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

A method is described for solving the line-transfer equations for a two-component atmosphere consisting of an array of columns, characterized by a particular variation of temperature with height, that are embedded in a medium in which the temperature is a different function of height. Radiative interaction between the two regions is taken into account, and the opacity is allowed to vary arbitrarily with depth. Some calculations that correspond to the solar Ca K-line are described. (auth) (UK)

58469 STELLAR ATMOSPHERES PROBLEM. Auer, L. H. (Yale Univ., New Haven). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 573-87(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

The construction of model stellar atmospheres is discussed placing particular stress on the mathematical methods used. The basic equations and assumptions of the problem are presented. Techniques which reduce the transfer equation to a set of linear equations are developed. It is shown how the constraint of radiative equilibrium may then be included directly into the transfer equation, yielding much more powerful methods for constructing model atmospheres than previously available. The scheme where all equations and constraints are solved simultaneously via full linearization is also given, and possibilities for improvement are briefly discussed. (auth) (UK)

58470 A MODIFIED FEAUTRIER METHOD. Rybicki, G. B. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 589-95(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

A modification of the Feautrier method of solving transfer problems is presented that allows advantage to be taken of such simplifications as isotropic scattering and complete frequency redistribution. The method has timing and storage requirements comparable to integral equation methods, but retains the ease of formulation of differential methods. The case of a two-level atom is treated in detail, and an appropriate generalization is sketched for the treatment of multi-level cases by means of a complete linearization technique. (auth) (UK)

58471 GREY RADIATIVE TRANSFER. Pomraning, G. C. (Science Applications, Inc., La Jolla, Calif.). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 597-615(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

The general problem of reducing a frequency-dependent radiative-transfer problem to an equivalent grey problem is discussed. In particular, an asymptotic solution is constructed from the integral transport equation to be used in forming grey opacities. This is closely related, but not identical, to the so-called B-N method widely used in neutron transport work. This leads to generalizations, to nonzero temperature gradients, of the standard Planck and Rosseland mean opacities. The mean opacities relevant to higher angular moments of the equation of transfer are also obtained. It is shown how the angular dependence of this asymptotic result can be incorporated into the grey equation of transfer without introducing an angularly dependent opacity. It is only necessary to modify the scattering kernel. The dominant term in the modification depends upon the difference between the Planck and Rosseland mean opacities. The resulting grey equation is shown to be exact in the two limiting cases of optically thin and thick systems where it is well known that the standard Planck and Rosseland means, respectively, are the appropriate averages. Numerical results are presented for idealized absorption coefficients, such as the Elsasser band (an infinite array of equally spaced, equal strength Lorentz lines) and a $1/v^3$ behavior (characteristic of bound-free and free-free transitions). The generalized Planck and Rosseland means are calculated and their dependence upon the temperature gradient exhibited. Results from the grey equation of transfer are compared with an exact frequency-dependent result for a model problem and shown to be significantly more accurate than those predicted by the usual grey models employing the standard Planck and Rosseland means. All of the considerations apply to the formation of a multigroup equation of transfer as well as to a grey, or one group, equation. (auth) (UK)

58472 SOME ASPECTS OF THE NON-LTE PHYSICS OF THE HELIUM ATOM IN HOT STARS. Underhill, A. B.; Hearn, A. G. Sonneborgh Observatory, Utrecht. Observatoire de Nice). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 617-22(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

In the atmospheres of the hot stars (types O and B), the populations of the states of the helium atom are significantly different from the LTE populations. This not only gives a change in the line source function with a consequent change in the predicted line depths, but it also changes the scale of the optical depths in the lines, with a consequent change in the deduced abundance of helium. Some exploratory numerical results are given to illustrate these effects, which could explain the observed variations of the strengths of the He I and He II lines in O and B type stars. There is an important coupling between the intensities of the He I lines in the visible region of the spectrum and radiation densities at wavelengths less than 584 Å. (auth) (UK)

58473 LINE AND CONTINUUM PROBLEMS IN GASEOUS NEBULAE. Osterbrock, D. E. (Univ. of Wisconsin, Madison). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 623-39 (Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

Gaseous nebulae are effectively transparent to nearly all the strong emission lines in the ordinarily observed spectral region, and if the physical conditions are known the calculation of the expected spectrum simply becomes a calculation of emission coefficients, without any intervention of radiative-transfer theory. For this reason astronomers tend to think of stellar- or planetary-atmosphere problems when they think of applications of radiative transfer theory. There are many important nebular radiative-transfer problems, particularly those of the ultraviolet continuum and resonance lines, which in fact fix the physical conditions throughout the nebula. Some of these problems are reviewed. (auth) (UK)

58474 RADIATIVE-TRANSFER EFFECTS IN CEPHEID ATMOSPHERES. Davis, Cecil G. Jr. (Los Alamos Scientific Lab., N. Mex.). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 647-53(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

The transfer equation, without retardation and considering scattering as absorption, is transformed by the moments expansion method for use in studying the dynamics of Cepheid atmospheres. The 0th and 1st moment equations are solved implicitly, using a variable Eddington factor (f) and 13 frequency groups. The f is calculated each time step by a characteristic ray plane transfer method. Results in a "bump" model (3.52 M_θ, $T_{eff} = 4585°K$) of R. Christy are presented and are compared to an observed 10.9 period Cepheid, V.X. Per. (auth) (UK)

58475 ECLIPSING VARIABLE IU AURIGAE. Mayer, P. (Charles Univ., Prague). Bull. Astron. Inst. Czech.; 22: No. 4, 168-87(1971).

UBV observations of IU Aur made in the years 1964 to 1971, numbering nearly 2500, are presented. Several new minima times are given and a periodic term in light elements is suspected. Color behavior can be explained by a third body light with an intensity about 0.20 (in V color); MK spectral type of the variable is B0:p:. The most interesting feature is perhaps the growth of minima depths: the depth of a primary minimum in V color in 1964 was about 0.470^m_u, in 1970 0.545^m_u. An orbital plane precession caused by the third body is probably responsible for it. (auth)

58476 EFFECTIVE TEMPERATURES AND GRAVITIES FOR A- AND F-TYPE STARS IN THE DELTA SCUTI REGION. Dickens, R. J; Penny, A. J. (Royal Greenwich Observatory, Sussex, Eng.). Mon. Notic. Roy. Astron. Soc.; 153: No. 3, 287-302(1971).

Effective temperatures and surface gravities are derived from spectrophotometry between 3500 Å and 8000 Å for 31 A- and F-type stars in or near the Delta Scuti region of the HR diagram. The stars include four Delta Scuti variables and ten stars known to be nonvariable. Excellent agreement is obtained with temperatures derived from VRI photometry. A brief discussion of the properties of all known variable and nonvariable stars in this region for which temperature, gravity, and an independent measurement of the absolute magnitude are available is given. Masses for the stars are poorly determined but are reasonably consistent with those expected for hydrogen-burning stars evolving off the main sequence. (auth) (UK)

58477 WOLF-RAYET STARS IN H II REGIONS. Crampton, David (Dominion Astrophysical Observatory, Victoria, British Columbia). Mon. Notic. Roy. Astron. Soc.; 153: No. 3, 303-14 (1971).

A catalogue of WR stars coincident with H II regions is presented. Approximately 44% of the WR stars surveyed are found to be "possibly" associated with nebulosity while the association is considered to be "probable" for 25% of the cases. Although the absorption derived from the WR stars is comparable to that from the OB stars in H II regions, the WR distance moduli are about one magnitude larger than those derived from the OB stars. An average decrease of 0.8 mag in the absolute magnitudes of galactic WR is indicated in apparent disagreement with the luminosities derived from WR stars in the Large Magellanic Cloud. A list of WR stars in open clusters is also given. (auth)

58478 UBV AND Hβ PHOTOMETRY OF THE ECLIPSING BINARY S VELORUM. Sistero, R. F. (Univ. Nacional, Cordoba, Argentina). Bull. Astron. Inst. Czech.; 22: No. 4, 188-96 (1971).

Photoelectric observations of 750 U, B, and V magnitudes and 39 Hβ strengths of the binary system S Vel are presented. The period of the system (5.9336663d) and orbital elements were studied. In combining photoelectric and spectroscopic elements the absolute dimensions are discussed. The system is an Algol-type binary with a normal A5 main-sequence primary component and a K5 undermassive secondary subgiant. (auth)

58479 DISSOCIATION EQUILIBRIUM OF SOME DIATOMIC MOLECULES IN DELTA CEPHEI. Pande, M. C.; Tripathi, B. M.; Murthy, C. S.; Gaur, V. P. (Uttar Pradesh State Observatory, Naini Tal, India). Bull. Astron. Inst. Czech.; 22: No. 4, 196-9 (1971).

The dissociation equilibrium of CO, CN, C_2, CH, NH, and OH is considered for the maximum and minimum phases of the light curve of δ Cep. Concentration-optical depth curves show that with both the phases the abundances decrease in the order CO, OH, CH, NH, CN, and C_2. The amplitude of the abundance variation decreases in the order CO, CN, C_2, OH, NH, and CH. (auth)

58480 INVESTIGATION OF THE CONSISTENCY OF THE CALIBRATIONS OF THE uvbyβ AND gnkmf PHOTOMETRIC SYSTEMS. Olsen, E. H. (Lowell Observatory, Flagstaff, Ariz.). Astron. Astrophys.; 15: No. 1, 161-72(Nov 1971).

Wide physical binary stars with G or K giant stars as primary components and A or F main-sequence stars as secondary components were observed photoelectrically; the primary components in the narrow-band gnkmf photometric system and the secondary components in the uvbyβ photometric system. Data in the gnkmf system are given for 32 double star components and data in the uvbyβ system for 34 double star components. (W.D.M.)

58481 DETERMINATION OF ATMOSPHERIC PARAMETERS FOR G AND K GIANTS BY MEANS OF PHOTOELECTRIC INDICES. Hansen, L; Kjaergaard, P. (Copenhagen Univ. Observatory). Astron. Astrophys; 15: No. 1, 123-60(Nov 1971).

The narrow-band photometry published by Dickow et al. (1970) was used for calibration of atmospheric parameters for G and K giants. It is shown that the dwarfs can be distinguished from the giants, and that stars with indices affected by interstellar reddening or duplicity can be eliminated. R – I and [Fe/H] are assumed to represent effective temperature and chemical composition, while a residual Δn from a relation between the cyanogen index n, R – I, and [Fe/H] is assumed to measure surface gravity. Calibrations giving R – I and $M_v(K)$ as functions of the observed indices are derived for giants in the intervals $0.40 < R - I < 0.65$ (G8–K3) and $0.65 < R - I < 0.88$ (K4–K5). Three calibrations giving [Fe/H] of the same indices are obtained for the G8–K3 giants (estimated standard deviation of the mean: 0.08); one of these calibrations may be extrapolated to the K4–K5 giants. Furthermore, [Na/H] can be derived for the G8–K3 giants from the above mentioned indices and the Cambridge ratio Na D. (auth)

58482 ACTIVITY PHASE OF CH CYGNI DURING THE PERIOD 1967 TO 1970. Faraggiana, R.; Hack, M. (Astronomical Observatory, Trieste, Italy). Astron. Astrophys.; 15: No. 1, 55-76(Nov 1971).

The spectrum of CH Cygni during the period July 1967–December 1970, following the explosion of June 1967, was studied using high-dispersion spectrograms. The main characteristics are discussed. (W.D.M.)

58483 OBSERVATIONS OF O AND Of STARS. Heap, S. R. (Univ. of California, Los Angeles). Astron. Astrophys.; 15: No.1, 77-89(Nov 1971).

Spectrograms with a dispersion of 16.2 Å/mm covering the spectral range λ3300 to λ4900 were obtained for three early O stars and three early Of stars. Detailed line profiles of selected hydrogen and helium lines were obtained, and equivalent widths of nearly all visible lines were measured. Comparison of the spectroscopic properties between Of stars and O stars suggest that Of stars have lower surface gravities than do O stars. Comparison of their photometric properties confirms this suggestion. Hence, present temperatures scales for O5–O8 stars should not be applied to Of stars until the effect of gravity in determining

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spectral type has been determined. In addition, the spectra suggest that atmospheric models of Of stars should take into account spherical and hydrodynamic effects. (auth)

58484 LINE BLANKETED MODEL ATMOSPHERE FOR ϵ VIRGINIS (HD 113226). Morgan, Thomas Edward. Bloomington, Ind.; Indiana Univ. (1971). 119p. University Microfilms Order No. 7117,451.

Thesis.

Using the line blanketing developed by Mutschlecner and Keller (Solar Physics, in press), LTE model bracketing of the previously derived parameters of ϵ Vir ($T_{eff} = 4940$ K, log g = 2.7) was completed. The effects of blanketing on predicted quantities were studied by means of the continuum energy distribution, broad- and intermediate-band multicolor magnitudes, and profiles of several strong absorption lines. In addition, the effect of line blanketing on the temperature–pressure structure of the models was investigated, and the present technique is compared with other blanketing methods suggested for cool stars. (TSS) (Diss. Abstr. Int., B)

58485 ATMOSPHERES OF PULSATING STARS. Stepien, Kazimierz (Astronomical Observatory, Warsaw). Postepy Astron.; 19: No. 3, 225-45(1971). (In Polish).

Observational data on pulsating stars are given. They are mainly spectrophotometric observations by Oke's group and photometric and spectroscopic observations by Preston's group. Evidence is presented that shock waves develop in the atmospheres of W Virginis stars and some RR Lyrae stars. A numerical kinematic model of W Virginis developed by Whitney is presented. This model is based on the assumption that the flux of strong shock waves is applied to the atmosphere of a W Virginis cepheid. Recent results on models of a δ Cephei-type star are discussed. Thick-zone models with the diffusion approximation of radiation transfer are compared with the thin-zone models in which the transfer equation is solved explicitly and with a set of static models computed with instantaneous values of effective gravity and of effective temperature. No large differences are found. (auth)

58486 PRESSURE INSIDE A ROTATING STAR. Abramowicz, M. A. (Zaklad Astronomii, Warsaw). Postepy Astron.; 19: No. 3, 247-53(1971). (In Polish).

The pressure decreases outward inside any rotating, relativistic star. (auth)

58487 SPACE DISTRIBUTION OF EVOLVING STARS IN M13. Blaghikh, Assia; Castellani, Vittorio (Univ., Rome). Astrophys. Space Sci.; 12: No. 1, 208 18(Jul 1971).

Information about space distribution was collected for selected classes of evolving stars in the globular cluster M13. After a rigorous elimination of field stars, three samples were examined, corresponding to the red giant stage (G), the blue (B), and the yellow (YG) parts of the horizontal branch. It is shown that results are easy to understand in terms of: (i) A substantial mass loss in the H-shell burning stage; (ii) Evolution along the horizontal branch from the blue side to the red one; and (iii) A mixing in the observed giant branch of two populations with sensible differences in masses. Theoretical interpretations are briefly discussed with reference to the reliability and usefulness of this type of investigation. (auth)

58488 STUDY OF THE WAVELENGTH DEPENDENCE OF INTERSTELLAR POLARIZATION USING A SCANNING SPECTROPOLARIMETER. Wolstencroft, R. D.; Nandy, K. (Royal Observatory, Edinburgh). Astrophys. Space Sci.; 12: No. 1, 158-64(Jul 1971).

A scanning spectropolarimeter was constructed and used in a preliminary search for conspicuous features of the interstellar polarization curve between $\lambda^{-1} = 1.58\ \mu^{-1}$ and $2.50\ \mu^{-1}$. The instrument was used at the f/4.5 prime focus of the 36" telescope of the Cambridge University Observatories. Scans were made on HD2905, HD21389, α And, and β Tau with slitwidths of 50 Å and 100 Å. The commonly adopted method of correcting for instrumental polarization by using observations of unpolarized stars was applied. The normalized polarization curves corrected for instrumental polarization for HD2905 and HD21389 reveal a feature near $\lambda^{-1} = 1.68\ \mu^{-1}$ which is most probably of interstellar rather than instrumental origin. (auth)

58489 INTRINSIC VARIATIONS OF INTERSTELLAR EXTINCTION LAWS. Nandy, K.; Napier, W. M.; Thompson, G. I. (Royal Observatory, Edinburgh). Astrophys. Space Sci.; 12: No. 1, 151-7(Jul 1971).

The intrinsic ultraviolet colors of early-type stars were derived from the rocket data of Campbell and Smith. There was a considerable spread in these colors. One possible source is the predicted rms variation due to the effect of rotation. It is necessary to recognize that rotation is an important source of uncertainty of the interstellar extinction curves derived from the comparison of pairs of stars. Predicted rms errors due to different sources (rotation, uncertainty of MK spectral type, photometric errors) were compared with the dispersion of the observed extinction data, and it was found that part of the large scatter could be due to intrinsic differences of the properties of interstellar grains. (auth)

58490 DETERMINATION OF NONLINEAR EFFECTS OF LIMB DARKENING IN ECLIPSING VARIABLES FROM OBSERVATIONS OF THEIR LIGHT MINIMA. Kopal, Zdenek (Univ. of Manchester, Eng.). Astrophys. Space Sci.; 12: No. 1, 147-50 (Jul 1971).

It is pointed out that observations of eclipsing variables within minima do not, in general, allow a separation of the quadratic terms of limb darkening from the first-order effects of the gravity darkening of distorted components undergoing eclipse. Only a difference of the two can be deduced from the observations, but—especially in close binaries—the net effect will be dominated by gravity darkening. (auth)

58491 EVOLUTION OF THE M31 DISK POPULATION. Tinsley, Beatrice M. (Univ. of Texas, Dallas); Spinrad, Hyron . Astrophys. Space Sci.; 12: No. 1, 118-36(Jul 1971).

An evolutionary model for the M31 inner disk population is described, which at age 12 billion years agrees closely with the narrow-band colors and line indices recently measured by Spinrad et al. (1971), and with the broad-band colors from 0.36 to 3.4 μ. Assuming that gE galaxies have the same stellar population as the M31 inner disk, this model is used to derive evolutionary effects in cosmology. Interpretation of the magnitude–redshift relation is substantially affected, since the evolutionary correction to V magnitudes at redshift 0.2 may be 0.09 mag. if $H_0 = 100$ km s^{-1} Mpc^{-1}, or ≥ 0.25 mag. if $H_0 = 50$. Changes in some line strengths may be observable at redshift 0.46, showing the younger stellar population at earlier times. The results differ from estimates by other authors, also based on the assumption that the gE and disk populations are identical, that the photometry of Spinrad et al. (1971) precludes a significant rate of evolution. One reason for the difference is that the model has an unexpectedly shallow luminosity function just below the main sequence turnoff; another reason is that authors in the past have used the change in absolute V magnitude as the evolutionary correction, whereas the appropriate quantity is the change in absolute magnitude at the emitted wavelengths, and evolution is more rapid at these shorter wavelengths. (auth)

58492 URCA PROCESS AT HIGH TEMPERATURES AND DENSITIES. McFee, R. W; Schlitt, D. W. (Univ. of Nebraska, Lincoln). Astrophys. Space Sci.; 12: No. 1, 4-9(Jul 1971).

The URCA neutrino loss rate from a hot stellar environment is investigated. The results indicate that the loss rates for URCA-type processes from even-mass-number nuclei are comparable to the rates from odd-mass-number nuclei at temperatures above about 10^9 K. Rates are calculated for some typical odd-mass isobar pairs and for the even-mass isobar fifty-six for temperatures between 5×10^8 K to 5×10^{10} K. (auth)

58493 NEUTRON STAR MODELS. Boerner, Gerhard (City Coll., New York); Sato, Katsuhiko. Astrophys. Space Sci.; 12: No. 1, 40-6(Jul 1971).

Neutron-star models are calculated using an equation of state discussed in an earlier paper. A maximum mass for a neutron star of 1.74 solar masses is found. The central density of the star is 3.3×10^{15} g/cm^3. The lightest stars have masses of 0.02 (resp. 0.03) solar masses with central densities 2.2×10^{14} g/cm^3 (resp. 1.9×10^{14}). (auth)

58494 STRUCTURE OF RAPIDLY ROTATING RELAXED GLOBULAR CLUSTERS. Kormendy, John; Anand, S.P.S. (Univ. of Toronto, Richmond Hill, Ont). Astrophys.Space Sci; 12: No.1, 47-57(Jul 1971).

A model of rapidly rotating globular clusters was constructed, assuming uniform angular velocity and a truncated Maxwellian distribution in the stellar velocities. Since the first-order theory developed by Woolley and Dickens becomes inaccurate for rapid rotation, a small-mass envelope was fitted to their models by the method of Monaghan and Roxburgh. A comparison was made of the critical values derived by the two methods. (auth)

58495 RAPIDLY ROTATING POLYTROPES IN POST-NEWTONIAN APPROXIMATION TO GENERAL RELATIVITY.

Fahlman, G. G.; Anand, S. P.S. (Univ. of Toronto). Astrophys. Space Sci.; 12: No. 1, 58-82(Jul 1971).

The study of uniformly rotating polytropes with axial symmetry was extended to include all rotational terms of order Ω^4, where Ω is the angular velocity, consistently within the first post-Newtonian approximation to general relativity. The equilibrium structure was determined by treating the effects of rotation and post-Newtonian gravitation as independent perturbations on the classical polytropic structure. The perturbation effects are characterized by a rotation parameter $v = \Omega^2/2\pi G\rho_c$ and a relativity parameter $\sigma = p_c/\rho_c C^2$, where p_c and ρ_c are the central pressure and density, respectively. The solution to the structural problem was obtained by following Chandrasekhar's series expansion technique and was complete to the post-Newtonian rotation terms of order σv^2. The critical rotation parameter v_c, which characterizes the configuration with maximum uniform rotation, was accurately evaluated as a function of σ. Numerical values for all the structural parameters needed to determine the equilibrium configurations are presented for polytropes with indices $n = 1$, 1.5, 2, 2.5, 3, and 3.5. (auth)

58496 RAPIDLY ROTATING SUPERMASSIVE STARS IN THE FIRST POST-NEWTONIAN APPROXIMATION TO GENERAL RELATIVITY. Fahlman, G. G; Ananad, S. P. S. (Univ. of Toronto). Astrophys. Space Sci.; 12: No. 1, 83-97(Jul 1971).

The structure and stability of rapidly uniformly rotating supermassive stars was investigated using the full post-Newtonian equations of hydrodynamics. The standard model of a supermassive star, a polytrope of index three, was adopted. All rotation terms up to and including those of order Ω^4, where Ω is the angular velocity, were retained. The effects of rotation and post-Newtonian gravitation on the classical configuration were explicitly evaluated and shown to be very small. The dynamical stability of the model was treated by using the binding energy approach. The most massive objects were found to be dynamically unstable when $\sigma = 1/c^2 \cdot p_c/\rho_c \gtrsim 2.2 \times 10^{-3}$, where p_c and ρ_c are the central pressure and density, respectively. Hence, the higher-order terms considered did not appreciably alter the previously known stability limits. The maximum mass that can be stabilized by uniform rotation in the hydrogen-burning phase was found to be 2.9×10^6 $M_\odot$, where $M_\odot$ is the solar mass. The corresponding nuclear-generated luminosity of $\sim 6 \times 10^{44}$ erg/sec^{-1} is too small for the model to be applicable to the quasi-stellar objects. The maximum kinetic energy of a uniformly rotating supermassive star was found to be 3×10^{-5} Mc^2, where M is the mass of the star. Masses in excess of 10^{10} $M_\odot$ are required if an adequate store of kinetic energy is to be made available to a pulsar like QSO. However such large masses have rotation periods in excess of 100 yr and thus could not account for any short term periodic variability. It was concluded that the uniformly rotating supermassive star does not provide a suitable base for a model of a QSO. (auth)

58497 POSSIBLE BLACK HOLE IN BETA LYRAE. Devinney, E. J. (Univ. of Florida, Tampa). Nature (London): 233: No. 5315, 110-12(10 Sep 1971).

It is stated that β-Lyrae is one of the most controversial and puzzling of binary systems. The central issue concerns the absolute masses of the two components. Although spectroscopy does not reveal the mass ratio of the components, the photometry of the system provides important information through the photometric effect of tidal and rotational distortion, and an attempt is made to use this effect to determine the mass ratio by fitting theoretical light curves to observations throughout the phase interval between eclipses. The calculations presented are adapted from a program for computing monochromatic complete light curves of close binaries in which all distortion and mutual irradiation effects are considered. Reasons are given as to why β-Lyrae is a most interesting exception in which the photometric technique can be applied to determination of the mass ratio. It is considered to be virtually certain that the secondary must be a very remarkable object, at least four magnitudes underluminous for its mass. The large value for its mass excludes the possibility of its being a white dwarf or neutron star, but it may be a "black hole", or perhaps some previously unknown stellar state. The importance of this system for understanding the nature of massive underluminous stars is considered to be great. (UK)

58498 BLACK HOLES AS AGENTS OF MAGNETIC FIELDS. Wald, R. M. (Princeton Univ., N. J.). Nature (London): 233: No. 5314, 52-3(3 Sep 1971).

It is contended that it is highly unlikely that the magnetic field of a "black hole" could ever be large enough to produce astrophysically observable effects. There is considerable evidence that the only electromagnetic field a "black hole" can have is the Kert Newman field, of which the magnetic dipole moment is a convenient strength indicator. Firm upper limits are obtained for such a field. (UK)

58499 ANALYTIC MODEL OF ECLIPSING BINARY STAR SYSTEMS. Wood, David B. (Bellcomm, Inc., Washington, D. C.). Astron. J.; 76: No. 8, 701-10(Oct 1971).

A new approach to the modeling of eclipsing binary star systems is described. The model takes advantage of a digital computer and thus allows a reduction in the number of simplifying assumptions and eliminates rectification altogether. The validity of this model is tested through analysis of numerical integration errors, comparison with the spherical model, parametric studies, and application to observational data. It is concluded that the model is a valid representation of eclipsing systems, and that it is a useful tool for the analysis of such systems. (auth)

58500 CATALOGUE OF CARBON STARS IN THE SOUTHERN MILKY WAY. Westerlund, B. E. (European Southern Observatory, Santiago de Chile). Astron. Astrophys., Suppl. Ser.; 4: No. 1, 51-74(Aug 1971).

An objective-prism survey in infrared light was carried out of the southern Milky Way from $l^{II} = 235°$ to $l^{II} = 7°$ and between $b^{II} = \pm 5°$. The present catalogue gives positions and estimated visual and infrared magnitudes for 1124 carbon stars identified in the survey. The positions of the stars will be given on overlays to an Atlas of the southern Milky Way, which is under preparation. (auth)

58501 WAVELENGTH SHIFTS OF INTENSITY MINIMA IN TYPE-I SUPERNOVA SPECTRA. Branch, D.; Patchett, B. (Royal Greenwich Observatory, Hailsham, Eng.). Nature (London) Phys. Sci.; 233: No. 37, 29-30(13 Sep 1971).

Attempts have been made to interpret Type-I supernova spectra as solid-state absorption bands superposed on continuous backgrounds, and bands of Fe ions in crystals such as garnet silicates or bands of metal atoms trapped in hydrocarbons have been implicated. It is pointed out, however, that such identifications, based on coincidences between laboratory wavelengths for the solid-state bands and measurements in published supernovae spectra, have not taken into account the fact that some features in Type-I spectra undergo substantial wavelength shifts (Minkowski, Astrophys. J., 89: 156(1939)). Such shifts were used to test the proposed identifications on the assumption that bands of common origin would show similar behavior. Wavelengths of intensity minima in spectra of IC 4182, NGC 4496, and NGC 1003 are shown graphically, and the spectra are discussed, particularly with reference to interstellar diffuse bands and identifications of the observed minima with the diffuse bands and with reference to wavelength shifts. An association between supernova features and diffuse bands was not entirely disproved, since the bands could originate in various kinds of grains, but such an hypothesis is made less attractive by the findings. (UK)

58502 Am STARS AS POSSIBLE MEMBERS OF TWO SUBGROUPS OF THE SCORPIUS–CENTAURUS ASSOCIATION. Glaspey, John W. (Univ. of Arizona, Tucson). Astrophys. J.; 169: No. 3, 525-7(1 Nov 1971).

Photometric evidence suggests that the Am star HD 148321 is not a member of the Upper Scorpius subgroup of the Scorpius–Centaurus association. An Am star in the Upper Centaurus subgroup, HD 119674, is a possible member. (auth)

58503 ENERGY DISTRIBUTIONS AND SPECTRA OF ORION B STARS. Schild, Rudolph E.; Chaffee, Frederic (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J.; 169: No. 3, 529-36(1 Nov 1971).

New MK spectral types and energy distributions are presented for B stars in Orion for which far-ultraviolet flux excesses have recently been discovered. Significant differences between HD spectral types and the new MK types were found. Moreover, the energy distributions showed the Orion late B stars to have smaller Balmer discontinuities than do field stars of the same spectral types. For the late B stars, these effects cause the 1500 Å fluxes to be underestimated by approximately 0.5 mag. No comparable systematic effects were found for the early B stars. (auth)

58504 SPECTRUM OF LkHα-101 IN THE NEAR-INFRARED. Herbig, G. H. (Univ. of California, Santa Cruz). Astrophys. J.; 169: No. 3, 537-41(1 Nov 1971).

LkHα-101 is the $m_{pg} = 17$ star that appears to be the source of illumination of NGC 1579, and which has recently been found to be very bright in the infrared by Cohen and Woolf and by Kleinmann. In the near-infrared, the spectrum contains many narrow emission lines of H, O I, [O II], [Fe II], [Cr II], . . ., together with a

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number of unidentified features that were found in η Car by Thackeray. The emission-line spectrum is quite unlike that of the T Tauri stars, or of VY CMa. The distance, inferred from UBV data for two B-type stars lying in the same dark cloud, is at least 800 pc. (auth)

58505 TWO YOUNG BRIGHT INFRARED OBJECTS. Cohen, Martin (Cambridge Univ., Eng. Univ. of Minnesota, Minneapolis); Woolf, N. J. Astrophys. J.; 169: No. 3, 543-7(1 Nov 1971).

Infrared photometric observations between 2μ and 22μ are reported for LkHα-101 and LkHα-190. LkHα-101 is currently the brightest infrared source known at the center of a cometary nebula. The spectral distribution is a broad peak resembling a blackbody of ~750°K but with excess emission to longer wavelengths, and depressed to shorter wavelengths. Lick Hα-190, a recently brightened object photometrically resembling the FU Ori phenomenon, is about 4 mag fainter than LkHα-101 at 3 to 5 μ, but is equally bright at 20 μ. The energy distribution from 2 to 5 μ is interpreted as a reddened continuum. A double-peaked structure at 10 and 20 μ is interpreted as a moderately thick silicate shell at ~110°K. (auth)

58506 SOME DOUBLE-LINED ECLIPSING BINARIES WITH METALLIC-LINE SPECTRA. Popper, Daniel M. (Univ. of California, Los Angeles). Astrophys. J.; 169: No. 3, 549-62 (1 Nov 1971).

Spectroscopic orbits were obtained for the metallic-line eclipsing binaries XY Cet, RR Lyn, and MY Cyg. Provisional orbits are also given for the A-type giant SZ Cen. In conjunction with available photometric results, these orbits lead to the properties of the components. These systems are shown in the (log m, log R)- and [(B − V), log g]-planes in two of the figures, along with systems previously discussed, β Aur, WW Aur, TX Her, CM Lac, V477 Cyg, and EI Cep. Sirius is included. The regions of metallicism in these planes are roughly delineated. The incidence of metallicism in some other eclipsing binaries of type A is discussed briefly. The membership of RR Lyn in the Ursa Major stream is shown to be unlikely, and that of β Aur questionable. (auth)

58507 OSCILLATIONS OF A MAGNETIC POLYTROPE. Trehan, S. K.; Billings, Dana F. (Univ. of Colorado, Boulder). Astrophys. J.; 169: No. 3, 567-84(1 Nov 1971).

The second-order-tensor virial formulation for gaseous configurations with a prevalent magnetic field is applied to determine the effect of a weak poloidal magnetic field on the fundamental modes of oscillations of a polytrope. The theory of polytropes with a poloidal magnetic field is reviewed and simplified. The various tensors, in terms of which the characteristic frequencies of oscillation are expressed, are evaluated correctly to first order in h (the ratio of the magnetic to the gravitational energies, apart from a numerical factor). It is found that of the nine modes of oscillation, three are neutral, four are nonradial, and two are the coupled radial and the nonradial modes. The results of the effect of a weak magnetic field ($h \ll 1$) on the various modes of oscillation are tabulated for polytropic indices n = 1, 1.5, 2, 3, 3.5, and 4. (auth)

58508 ELEMENT PRODUCTION IN SIMPLE HELIUM BURNING. Hansen, Carl J. (Univ. of Colorado, Boulder). Astrophys. J.; 169: No. 3, 585-8(1 Nov 1971).

The final abundances of the α-nuclei (^{12}C, ^{16}O, ^{20}Ne, etc.) resulting from helium burning at constant temperature and density were computed by using recently available reaction rates. For one density (10^5 g cm^{-3}) the calculation was extended up to a temperature high enough to demonstrate the emergence of the e-process. (auth)

58509 COLLISION BROADENING BY NEUTRAL HYDROGEN. Brueckner, Keith A. (Univ. of California, San Diego). Contract AT(11-1)-Gen-10. Astrophys. J.; 169: No. 3, 621-32(1 Nov 1971).

The theory of collision broadening by neutral hydrogen is summarized and given in simplified form. The error introduced by averaging over azimuthal quantum numbers is exhibited and shown to be small. The multipole expansion as usually used is shown to give very slow convergence. The exact expression is evaluated, avoiding the multipole expansion but using scaled hydrogenic functions, and is applied to the lines of Fe I. The predictions for the line width are considerably larger than the dipole−dipole estimate and are in reasonable agreement with the average broadening observed experimentally. (auth)

58510 RADIATIVE TRANSFER IN SPHERICALLY SYMMETRIC SYSTEMS. II. THE NON-CONSERVATIVE CASE AND LINEARLY POLARIZED RADIATION. Cassinelli, J. P.; Hummer, D. G. (National Bureau of Standards, Boulder, Colo. Univ. of Colorado, Boulder). Mon. Notic. Roy. Astron. Soc.; 154: No. 1, 9-21(1971).

The method for the solution of transfer problems in spherically symmetric systems developed recently by Hummer and Rybicki (Mon. Not. Roy. Astron. Soc., 152: 1(1971)) is generalized to the nonconservative case. This procedure, which depends on the iterative determination of the Eddington factor $f = K/J$, handles in a natural way the outward peaking of the radiation field which occurs in extended atmospheres. To illustrate the present extension of this method, solutions are obtained for the problem of scattering of linearly polarized radiation by an extended electron-scattering atmosphere. Although the transfer of radiation through such an atmosphere is conservative, each of the component equations is not. For opacity laws of the form $\kappa\rho = r^{-n}$, $o < r < R$, $n =$ 2 and 3, very large values of the polarization are found as a general feature arising from the strong peaking of the radiation field. It is found that the temperature distribution in such extended electron-scattering atmospheres differs negligibly from that computed on the assumption of isotropic scattering, with the neglect of polarization. The procedure used for the polarization problem can also be applied directly to problems with a nongrey opacity involving many frequencies simultaneously. (auth)

58511 EFFECTIVE TEMPERATURE, RADIUS, AND GRAVITATIONAL REDSHIFT OF SIRIUS B. Greenstein, J. L.; Oke, J. B.; Shipman, H. L. (California Inst. of Tech., Pasadena). Astrophys. J.; 169: No. 3, 563-6(1 Nov 1971).

Analysis of the Hα and Hγ line profiles in Sirius B, along with the apparent magnitude and parallax, yields $T_{eff} = 32000° \pm 1000°K$, $\log g = 8.65$, and $R/R_\odot = 0.0078 \pm 0.0002$. These values put Sirius B on the mass−radius relation for degenerate configuration of helium. The measured gravitational redshift is 89 ± 16 km s^{-1}, which is in excellent agreement with that predicted by the radius and gravity. (auth)

58512 SEARCH FOR INTERSTELLAR SILICATE ADSORPTION IN SPECTRUM OF VI CYG NO. 12. Stein, W. A.; Gillett, F. C. (Univ. of California, San Diego. Univ. of Minnesota, Minneapolis). Nature (London) Phys. Sci.; 233: No. 39, 72-3(27 Sep 1971).

The star VI Cyg No. 12 was examined up to 11 μm in an attempt to detect interstellar silicate absorption and to compare the results with those of others. A plot of the energy distribution is shown, from data obtained at the Kitt Peak National Observatory and from the UCSD-UM 60-inch telescope at Tucson, Arizona. No absorption at 11 μm that could be attributed to silicate-type material was observed and there was no evidence of excess at 11 μm that would be expected if silicate grains were close enough to the star to be heated by stellar radiation. Upper limits to the amount of absorbing materials in the line of sight to the star are estimated, including estimates for enstatite and olivine. It appears to be likely that a significant amount of the grain material in the line of sight consists of materials other than silicates, and uv observations have produced strong evidence in favor of interstellar graphite. (UK)

58513 EMISSION-LINE SPECTRUM OF THE ORION NEBULA IN THE WAVELENGTH RANGE 4959 TO 8665 A. Morgan, Lesley A. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.). Mon. Notic. Roy. Astron. Soc.; 153: No. 4, 393-9(1971).

Among new lines identified were eight O I lines whose intensities cannot be accounted for by recombination. The [Cl IV] line λ7531 was seen for the first time; from its intensity it was found that the abundance of Cl^{3+} is small compared to that of Cl^{2+}. Using this result and the intensities of the [Cl III] lines given by Aller and Liller it was found that $N(Cl)/N(O^{2+}) \simeq 0.008$. (auth) (UK)

58514 CYGNUS LOOP AT 1420 MHz. Moffat, P. H. (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 153: No. 4, 401-12(1971).

Part of the Cygnus Loop was mapped at 1420 MHz, using the Cambridge half-mile telescope with a resolution of $140'' \times 280''$. The source has a complex structure which is closely associated with that of the optical nebula. A high fractional polarization in the southern part of the source implies a magnetic field aligned parallel to a fairly well defined shell structure. The radio spectrum of the northeastern part of the source shows that the emission is nonthermal, but is not measurably polarized. The implications of the observations are discussed, with particular reference to van der Laan's theory of the radio emission and the possibility that the optical "filaments" are excited by the shock wave at the boundary of the supernova remnant. (auth) (UK)

58515 TIME VARIATIONS IN THE EMISSION LINES OF Of STARS. Brucato, Robert J. (Northwestern Univ., Evanston, Ill.). Mon. Notic. Roy. Astron. Soc.; 153: No. 4, 435-52(1971).

Spectrograms covering the region between Hβ and Hγ at a reciprocal dispersion of 28 Å mm^{-1} were obtained for the Of stars HD 108, HD 188001 (9 Sge), HD 190429N, HD 192639, HD 210839 (λ Cep) and, at 42 Å mm^{-1}, for HD 66811 (ξ Pup). Equivalent widths were measured for several spectral features, particularly N III $\lambda\lambda$4634–40–41 and He II λ4686. The strengths of these lines are shown to vary in several of these stars with time scales of the order of 10 min, with the most striking changes occurring at λ4686 in the earliest spectral types. (auth) (UK)

58516 CALCULATIONS OF THE LEVEL POPULATIONS FOR THE LOW LEVELS OF HYDROGENIC IONS IN GASEOUS NEBULAE. Brocklehurst, M. (University Coll., London). Mon. Notic. Roy. Astron. Soc.; 153: No. 4, 471-90(1971).

The level populations, b_{nl}, of hydrogen and singly ionized helium are calculated making full allowance for collisional redistribution of angular momentum and energy. In many cases the l-states are not populated statistically. Intensities of the most important line series are presented for the principal quantum number $n \leq 40$ and for a wide range of electron temperatures and electron densities. Calculated relative intensities in the spectra of H I are compared with observed intensities in the planetary nebula NGC 7662. The agreement with the photoelectric observations is good, but there is poor agreement with the photographic observations. (auth) (UK)

58517 ENERGY DISTRIBUTIONS OF MAIN-SEQUENCE STARS. Stickland, David J. (Royal Greenwich Observatory, Hailsham, Eng.). Mon. Notic. Roy. Astron. Soc.; 153: No. 4, 501-20(1971).

A wide range of MK standard main-sequence stars was observed with a spectrum scanner and spectral energy distributions derived. These were corrected, where necessary, for the effects of interstellar reddening and line blanketing. The flux curves so obtained were compared with the predictions of several recent sets of model stellar atmospheres through a scheme of parametrization in which the main characteristics of the curves are represented by a Balmer discontinuity parameter and three spectral gradients. While the general features are predicted, even the most sophisticated grids of models fail to reproduce the fine details of the energy curves for the whole range of spectral types. (auth) (UK)

58518 IMPORTANCE OF CIRCULATION IN RADIATIVE STELLAR ENVELOPES. Smith, R. Connon (Univ. of Sussex, Brighton, Eng.). Mon. Notic. Roy. Astron. Soc.; 153: No. 4, 33P-5P(1971).

It is shown that a recently proposed rotation law (Marks and Clement, Astrophys. J., 166: L.27(1971)) cannot be relevant to many observed early-type stars. (auth) (UK)

58519 PHENOMENA OF FLUORESCENCE IN STARS. Swings, P. (Univ., Liege). Mem. Soc. Roy. Sci. Liege; 1: No. 2, 131-41(1971). (In French).

Some atomic rays and molecular bands appear in emission from various heavenly bodies; this emission is frequently due to a fluorescence mechanism. Several examples of experimental studies are described. The following astronomical phenomena are then discussed: (1) presence of lines from In, Ga, Sc, and Ti in long-period variable stars; (2) presence of unresolved multiplets of Fe I in variable cold stars; (3) emission lines of Mn I, excited by λ2794 and λ2801 of Mg II in variable cold stars; (4) atomic and molecular emissions produced by photodissociation, photochemical luminescence, and induced predissociation; (5) the Bowen mechanism; (6) the possibility of the transition n = 4 to n = 3 in He II with an emission of λ4686; (7) selectivity among the emission lines of He I, O I, C III, N IV, Si III, Si II, Fe II, N II, C II, H, etc., in hot stars; and (8) the possibility of fluorescence phenomena in the ultraviolet region of symbiotic stars, of variable to long-period stars, and of comets. (tr-auth)

58520 EXTREME REGIMES OF TEMPERATURE AND PRESSURE IN ASTROPHYSICS. Ruderman, Malvin A. (Columbia Univ., New York). Pure Appl. Chem.; 22: No. 3-4, 429-47(1970).

From International conference on thermodynamics; Cardiff, Wales (1 Apr 1970).

States of matter and phenomena in extreme régimes of temperature and density found in the Universe are surveyed: thermodynamics and stellar evolution, terminal states of stars, temperatures of stars, forms of superdense matter in stars, crystallization of superdense stellar matter, neutron star structure, and low temperature phenomena in neutron stars. (auth) (UK)

58521 THERMODYNAMICS OF HYPERON STARS. Koebke, K.; Hilf, E. (Univ., Wuerzburg, Ger.). Pure Appl. Chem.; 22: No. 3-4, 469-80(1970).

From International conference on thermodynamics; Cardiff, Wales (1 Apr 1970).

For a single-component perfect Fermi gas, the numerical program for the equation of state given by Bauer was used. For a star of hot nondegenerate neutron gas, the deviations of the internal structure with regard to a totally degenerate neutron star were calculated. For a multi-component perfect gas with an exponential-type elementary particle spectrum the equation of state is given. The highest possible temperature is $T_0 = 2 \times 10^{12}$°K, where the total mass density diverges. For the central region of hyperon stars, in contrast to previous work, it can be proved that the time component of the metric tensor has no singularity, and that the velocity of sound tends to zero (instead of rising above the velocity of light). (auth) (UK)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 58700.

58522 (CSIRO-Trans–10649) SLOW VARIATIONS OF PULSAR RADIO EMISSION. Erukhimov, L. M. Translated by G. Losonci (Commonwealth Scientific and Industrial Research Organization), from Astron. Tsirk.; No. 513, 3-5(1969). 3p. Dep. NTIS (U. S. Sales Only).

It is shown that the dependence of time scale on the total column of electrons and velocity of the source is made clear by taking into account the minute variations of large inhomogeneities ($l_0 \sim 10^{13}$ cm), which may be responsible for the observed variations in pulsar emission of $\tau \sim 10^5$ to 10^6 sec. (Australia)

58523 (CSIRO-Trans–10650) QUASARS: PRECLUSTERS OF GALAXIES. Vorontsov-Velyaminov, B. A. Translated by G. Losonci for Australian Atomic Energy Commission Research Establishment, Lucas Heights from Astron. Tsirk.; No. 513, 5-7 (1969). 5p. Dep. NTIS (U. S. Sales Only).

An hypothesis is suggested, according to which quasi-stellar galaxies (quasags) produce radio emission from time to time, turning into quasars and readily disintegrating at this stage. Further chain fragmentation of quasags (solar masses 10^9 to 10^{13}) leads to formation of galaxy groups or clusters retaining the ability of nonthermal recurrent radio emission. The radio emission of dwarfs is therefore an elimination process. Identical forms with and without radio emission corresponding to fragmentation stages of initial objects in the metagalaxy are listed. (Australia)

58524 RADIO INTENSITY VARIATIONS OF 3C 273 AT 2.3 AND 8.15 mm. Efanov, V. A.; Kislyakov, A. G.; Moiseev, I. G.; Naumov, A. I. (Crimean Astrophysical Observatory, Moscow. Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 338-9(Sep-Oct 1971).

Translated from Astron. Zh.; 48: No. 2, 435-6(Mar-Apr 1971).

The radio flux density of 3C 273 was observed with the 22-m radio telescope of the Crimean Astrophysical Observatory. Comparisons with Jupiter yielded values (in late June, 1969) of $(51 \pm 3) \times 10^{-26}\ W \cdot m^{-2} \cdot Hz^{-1}$ at $\lambda = 8.15$ mm, and $(66 \pm 17) \times 10^{-26}\ W \cdot m^{-2} \cdot Hz^{-1}$ at $\lambda = 2.3$ mm. The spectral index of the source over the range 2 to 8 mm was therefore $\alpha = 0.15 \pm 0.25$. From May 1968 to June 1969 the flux density of the source decreased at both 8.15 mm and 2.3 mm, while the spectral index decreased from 0.4 ± 0.15 to 0.15 ± 0.25. The measurements of 3C 273 at $\lambda = 8.15$ mm are compared with other reports of the radio intensity of this source at nearby wavelengths. (auth)

58525 ABSOLUTE MEASUREMENTS OF THE RADIO INTENSITY OF VIRGO A IN THE 10 TO 30-cm RANGE. Dmitrenko, D. A.; Dmitrenko, L. V.; Ivanov, O. S.; Tseitlin, N. M. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 340-1(Sep-Oct 1971).

Translated from Astron. Zh.; 48: No. 2, 437-8(Mar-Apr 1971).

Absolute measurements of the radio flux density of Virgo A at wavelengths of 10, 13, 15, 20, 23, 25, 27, and 30 cm were made to 5 to 7% accuracy by comparison with the radiation of a "black" disk located in a Fresnel zone of a 7-m radio-telescope antenna. The spectral index for this wavelength range is 0.76 ± 0.1. (auth)

58526 POSSIBLE ANTENNA MECHANISM FOR COSMIC RADIO EMISSION. Kaplan, S. A.; Eidman, V. Ya. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 344-6(Sep-Oct 1971).

Translated from Astron. Zh.; 48: No. 2, 440-3(Mar-Apr 1971).

It is shown that intensive coherent generation of radio waves is

XUM

possible in neutral electric-field regions within powerful radio sources. (auth)

58527 INDUCED COMPTON SCATTERING BY THERMAL ELECTRONS AND THE LOW-FREQUENCY SPECTRUM OF RADIO SOURCES. Syunyaev, R. A. (Inst. of Applied Mathematics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 190-6(Sep-Oct 1971).

Translated from Astron. Zh.; 48: No. 2, 244-52(Mar-Apr 1971).

Induced Compton scattering by thermal electrons should produce characteristic distortions in the low-frequency radiation spectrum of radio sources if the radiation brightness temperature exceeds $kT_b = m_e c^2/\tau_T (1 + \tau_T)$. Even if the source has a small optical depth for Thomson scattering ($\tau_T \ll 1$), the conclusions remain valid. They are also independent of the electron temperature. If its spectrum is free from distortion, an upper limit can be set on the thermal-electron density in a compact radio source. (auth)

58528 IONIZED-HYDROGEN DISTRIBUTION IN THE GALAXY. Ariskin, V. I. (Lebedev Inst. of Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 197-202(Sep-Oct 1971).

Translated from Astron. Zh.; 48: No. 2, 253-9(Mar-Apr 1971).

An analysis of moderate-resolution ($\approx 40'$) galactic surveys in the H I line and in the continuum indicates that the Galaxy contains a number of large-scale H II regions, the main factor responsible for the thermal background radio emission. Some of these regions are spatially related to discrete sources of excited-hydrogen radio lines. The correlation increases if the individual compact H II zones are assumed to have peculiar radial velocities of ≈15 to 30 km/sec. (auth)

58529 LUNAR OCCULTATIONS OF RADIO SOURCES AS A TECHNIQUE FOR INVESTIGATING THEIR ANGULAR STRUCTURE. Abramyan, G. L. (Gorky State Univ., USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 210-13(Sep-Oct 1971).

Translated from Astron. Zh.; 48: No. 2, 269-74(Mar-Apr 1971).

A solution is given for the problem of determining the angular structure of a radio source from observations of its occultation by the Moon in a narrow frequency band with a large signal/noise ratio. The method developed is subjected to a numerical computer test simulating observational data. (auth)

58530 IDENTIFICATION OF COSMIC X-RAY SOURCES. Amnuel, P. R.; Guseinov, O. Kh. (Shemakha Astrophysical Observatory, Baku). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 218-24(Sep-Oct 1971).

Translated from Astron. Zh.; 48: No. 2, 280-7(Mar-Apr 1971).

The correlation is examined between discrete galactic x-ray sources and dark nebulae, H II regions, close binary stars, Wolf-Rayet stars, planetary nebulae, novae, and flare stars. An effort is made to obtain specific identifications. No correlation is found between these objects and the x-ray sources; in many cases no such object falls within the error box for the position of a given source. Evidently x-ray sources do not comprise a homogeneous group of objects; some of them might be relativistic stars undergoing accretion. (auth)

58531 GREEN BANK SKY SURVEY IN SEARCH OF RADIO SOURCES AT 1400 MHz. I. A SPECTRAL ANALYSIS OF THE 5C1 SOURCES. Maslowski, J. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. Astrophys.; 14: No. 2, 215-22(Sep 1971).

The NRAO 300-foot telescope was used to make a survey of the sky at 1400 MHz in a 6° strip of declination between $+45.8$ and $+51.7°$ and between right ascension 7h17m and 16h23m. A map of the full survey and a brief description of the observations and the reduction procedure are given. The region of the survey that overlapped the 5C1 survey is also briefly discussed. A limiting flux density $S = 0.09 \times 10^{-26}$ W m^{-2} Hz^{-1} of the survey was reached. (auth)

58532 POLARIZATION AND THE MAGNETIC FIELD SCALE IN RADIO SOURCES. Perola, G. C. (Univ., Milan). Astron. Astrophys.; 14: No. 2, 337-9(Sep 1971).

A statistical analysis of the intensity of the polarized radiation may help to determine the scale of the magnetic field in the extragalactic extended radio sources. (auth)

58533 X- AND γ-RAY ASTRONOMY BETWEEN 1962 AND 1970. Koch, L. (CEN de Saclay, Gif-sur-Yvette, France). Rech. Spatial.; 10: No. 3, 10-13(May 1971). (In French).

The principal results obtained in x- and γ-ray astronomy between 1962 and 1970 are presented. The sky background, the various x-ray sources (blue stars, nebulas, extragalactic objects) and γ-ray sources (the Crab and the galactic center) are considered. (France)

58534 EVIDENCE FOR A HIGHLY COMPACT X-RAY SOURCE. Margon, Bruce; Bowyer, Stuart; Lampton, Michael; Cruddace, Ray (Univ. of California, Berkeley). Astrophys. J.; 169: No. 2, L45-8(15 Oct 1971).

A detailed spectrum of the x-ray source GX 340 + 0 is presented. The spectrum may be fitted from 1 to 10 keV by a blackbody model at $T = 1.5 \times 10^7$ °K, subject to heavy photoelectric absorption. Unlike x-ray sources previously reported, the spectrum is not also compatible with power-law or thermal-bremsstrahlung models. If the source is a blackbody at the distance indicated by its x-ray absorption, its radius is 8 km and luminosity 3×10^{37} ergs s^{-1}. This source may provide direct evidence for the existence of a neutron star. (auth)

58535 CORRELATED TRANSIENT SHORT-PERIOD OSCILLATION IN THE OPTICAL AND X-RAY FLUX FROM SCORPIUS X-1. Kestenbaum, H. (Columbia Univ., New York); Angel, J. R. P.; Novick, R.; Cocke, W. J. Astrophys. J.; 169: No. 2, L49-55(15 Oct 1971).

Correlated oscillations with a 20-s period were detected in a simultaneous observation of the x-ray and optical flux from Sco X-1. The oscillations persist for about 2 minutes and have amplitudes of (0.81 ± 0.17) and (0.56 ± 0.17) percent in the x-ray and optical bands, respectively. (auth)

58536 EVIDENCE OF HIGH-FREQUENCY OSCILLATIONS IN THE X-RAY FLUX FROM SCORPIUS X-1. Angel, J. R. P.; Kestenbaum, H.; Novick, R. (Columbia Univ., New York). Astrophys. J.; 169: No. 2, L57-61(15 Oct 1971).

An analysis of the x-ray flux from Sco X-1 taken over a 4-minute period shows evidence for oscillations in the frequency range 1 to 10 Hz which persist for typically 1 minute. (auth)

58537 POSITIONAL DETERMINATION OF NP 0532. McNamara, Bernard J. (Univ. of California, Santa Cruz). Publ. Astron. Soc. Pac.; 83: No. 494, 490-1(Aug 1971).

A newly determined position, based on recent observational data, is given for the pulsar NP 0532 (Crab nebula). (auth)

58538 LUNAR OCCULTATION OBSERVATIONS OF 25 RADIO SOURCES MADE WITH THE OOTY RADIO TELESCOPE: LIST I. Swarup, G.; Kapahi, V. K.; Sarma, N. V. G.; (and others) (Tata Inst. of Fundamental Research, Bombay). Astrophys. Lett.; 9: No. 2, 53-9(Sep 1971).

A survey of radio sources by the method of lunar occultation is being carried out at Ootacamund in India with a large steerable telescope whose collecting area is 8700 m^2. Results for 25 weak radio sources with flux densities lying in the range 0.4 to 4 fu at 327 MHz are presented. Seven sources have clear double components with separations ranging from 2.5 to 20 arc sec. Optical identifications are suggested for 8 of the 25 sources, 5 of which are possibly QSOs. The unidentified radio sources seem to be galaxies with high redshifts. (auth)

58539 VERY BLUE STELLAR OBJECTS APPEARING NEAR GALAXIES. Weedman, Daniel W. (Vanderbilt Univ., Nashville). Astrophys. Lett.; 9: No. 2, 49-51(Sep 1971).

Because of Arp's discovery that the quasar Markarian 205 is connected to the spiral galaxy NGC 4319, the entire Palomar Observatory Sky Survey was searched for very blue stellar objects appearing in or near galaxies. Nine such objects were found, and finding charts are given for these. (auth)

58540 INTERSTELLAR SCATTERING AND THE LOW-FREQUENCY SPECTRUM OF PSR 0833-45. Higgins, C. S.; Komesaroff, M. M.; Slee, O. B. (CSIRO, Sydney). Astrophys. Lett.; 9: No. 2, 75-6(Sep 1971).

A small diameter radio source was detected at 80 MHz in the direction of PSR 0833−45. The measured flux of 12 ± 2 fu was consistent with the source being the "smeared out" low frequency radiation from the pulsar. This supports the view of Ables et al. (1970) that the spectral turnover in the pulsed component of the emission at higher frequencies is the result of radiation scattering. (auth)

58541 MEASUREMENT OF THE 10-μm FLUX FROM THE CRAB NEBULA. Aitken, D. K.; Polden, P. G. (Univ. Coll., London). Nature (London) Phys. Sci.; 233: No. 38, 45-6(20 Sep 1971).

Observations of the Crab Nebula during Jan. and Feb. 1971 are reported at an effective wavelength of 10μm using a 4 arcmin beam on the 24 inch reflecting telescope at the University of London Observatory, and employing a Ga-doped Ge bolometer cooled to 1.8K as detector, together with a CaF$_2$ filter to reduce sky noise and a three beam photometer to reduce the effect of sky emission fluctuations and gradients. Results are shown in tabular and graphical form. The average flux was found to be 170 ± 50 FU at 10μm, significantly in excess of the value 30FU expected for a synchrotron model. Possible reasons for such an excess are discussed. (UK)

58542 SEARCH FOR PULSED GAMMA RAY EMISSION ABOVE 50 MeV FROM NP 0532. Vasseur, J. (CEN, Saclay, France). Nature (London) Phys. Sci.; 233: No. 38, 46-8(20 Sep 1971).

Observations are reported from a series of balloon flights, carrying a telescope sensitive to γ rays > 50 MeV, carried out during 1969 in southern France, and employing a 13-plate optical spark chamber, triggered by a Cherenkov detector scintillator coincidental system. The technique and analytical methods used are described in detail, and results are shown in tabular and graphical form. No definite conclusions regarding pulsed γ emission were obtained, except for an upper limit for such emission. (UK)

58543 LINE FORMATION IN PULSATING VARIABLE STARS. Kalkofen, W.; Whitney, C. A. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Coll. Observatory, Cambridge, Mass.). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 531-43(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

An integral equation method is described that solves the equation of radiative transfer in a spectral line for an opacity that depends on depth, frequency, and angle, and an expression is derived for the line source function of a two-level atom in a gas that is traversed by a plane, steady shock wave. The simultaneous equations for the transfer of radiation in a line and for the gas flow through a shock front are solved and cases that are indicative of the line formation in variable stars such as W Virginis, are discussed. (auth) (UK)

58544 SURVEY OF MICROWAVE RADIATION FROM PLANETARY NEBULAE. Higgs, L. A. (National Research Council, Ottawa). Mon. Notic. Roy. Astron. Soc.; 153: No. 3, 315-36(1971).

Radio observations of 121 planetary nebulae were made at wavelengths of 9.3, 4.5, and 2.8 cm, using the 46-metre telescope at the Algonquin Radio Observatory. Detectable radio emission was found for approximately one half of these nebulae. Flux densities (or upper limits to flux densities) were determined with an accuracy of the order of 0.04 flux units. It is hoped that this body of data will be of use for the study of radio spectra of planetary nebulae. (auth) (UK)

58545 CHARACTERISTICS OF THE RADIO PULSES FROM THE PULSARS. Lyne, A. G.; Smith, F. G.; Graham, D. A. (Univ. of Manchester, Jodrell Bank, Eng.). Mon. Notic. Roy. Astron. Soc.; 153: No. 3, 337-82(1971).

The shape and structure of radio pulses from the majority of the pulsars were studied at frequencies of 151, 240, 408, and 610 MHz, using polarimeter receivers. Individual pulses from the stronger pulsars were recorded photographically. The integrated pulse profiles were obtained from on-line integration of the four Stokes parameters. Many of the results are presented graphically; the main characteristics are collected in a table. A discussion of the pulse widths and the change of polarization angle within the pulses supports the view that the integrated pulse profile represents a longitude distribution of emission, while the individual pulses represent individual beams of radiation. The changes of position angle within the profile suggest that the magnetic field has a simple configuration in the emitting region, and that it may resemble the equatorial part of a dipole field. New measurements of the rotation measures of five pulsars are presented together with a compilation of nine previous results. Some new measurements of period and position are also presented. (auth) (UK)

58546 OBSERVATIONAL EVIDENCE FOR STARK BROADENING IN RADIO RECOMBINATION LINES. Churchwell, E. (Max-Planck Institut fuer Radioastronomie, Bonn). Astron. Astrophys.; 15: No. 1, 90-4(Nov 1971).

Observations of the H109α and adjacent higher-order lines (H137β, H157γ, and H172δ) from Orion A and M17 indicate successively increasing line widths with increasing order. Since the telescope beamwidth, optical depth, and Doppler width are essentially the same for each line the excess broadening with increasing order is interpreted in terms of Stark broadening. It is concluded that Stark broadening does occur in the radio recombination lines emitted from Orion A and M17. The functional dependence of this broadening on the principal quantum number appears to follow an n^4 law as predicted by Griem (1967), however, evidence is given which indicates that the magnitude of Stark broadening has been over-estimated by Griem. (auth)

58547 DEGREE OF CIRCULAR POLARIZATION OF SYNCHROTRON RADIATION. Melrose, D. B. (Australian National Univ., Canberra). Astrophys. Space Sci.; 12: No. 1, 172-92 (Jul 1971).

Formulas describing synchrotron radiation were extended to include the effect of the presence of an ambient medium and the effect of reabsorption and Faraday rotation on the degree of circular polarization. Results were: (1) onset of Razin–Tsytovich suppression has no significant effect on the degree of circular polarization; (2) onset of self-absorption in a source subject to weak Faraday rotation (negligible Faraday rotation in an absorption length) causes the degree of circular polarization to reverse its sign and to decrease (by between one half and one quarter for typical parameters) in magnitude, and (3) as in (2) but for strong Faraday rotation (many rotations of the plane of polarization in an absorption length) the degree of circular polarization also reverses its sign and becomes slightly smaller in magnitude than for weak Faraday rotation. The transfer equation including the effects of the polarization is discussed in detail. (auth)

58548 OBSERVATION OF COSMIC SOFT X RAYS. Hayakawa, S. (Nagoya Univ., Japan); Kato, T.; Makino, F.; (and others). Astrophys. Space Sci.; 12: No. 1, 104-17(Jul 1971).

Cosmic soft x rays in the energy range between 0.14 and 7 keV were observed with thin polypropylene window proportional counters on board a sounding rocket. The field of view crossed the galactic plane in the Cygnus–Cassiopeia region at a large angle and reached the galactic latitudes of –55° and +30°. Referring also to the result with Be window counters, the energy spectrum of Cyg XR-2, the flux from the Cas A region, and the distribution of the intensity of diffuse x rays over the scanned region were obtained. The turnover of the Cyg XR-2 spectrum at about 1 keV indicated that the distance of the Cyg XR-2 source lies between 600 and 800 pc, if the turn-over is due entirely to interstellar absorption. The flux from the Cas A region was obtained as 0.23 ± 0.05 photons cm^{-2} sec^{-1} in the energy range between 1.1 and 4.1 keV. The intensity of diffuse soft x rays depends on the galactic latitude more weakly than expected from the interstellar absorption of extragalactic x rays and shows asymmetry with respect to the galactic equator, thus suggesting a contribution of galactic x rays. The spectrum of extragalactic x rays is approximately represented by a power law $E^{-1.8}$. (auth)

58549 PULSAR RADIO EMISSION FROM EXPANDING CHARGE SHEETS. Tademaru, E. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. Space Sci; 12: No.1, 193-203(Jul 1971).

The distribution of energy in frequency and angle emitted from a sheet of charges that are moving out relativistically along dipolar magnetic field lines originating near the magnetic polar caps of a rotating neutron star was calculated. The angular distribution is conical with the angle of maximum intensity varying with frequency ω as $\omega^{-1/3}$ for $\omega \lesssim \omega_c \approx 2c/(R\theta_M{}^2)$, where $R\theta_M$ is the initial angular radius of the charge sheet at the surface of the star of radius R. At higher frequencies the width of the angular cone remains constant. The radiation is linearly polarized with the polarization vector in the plane of the line of sight and the magnetic axis. A sheet of uniform charge density and finite thickness has a frequency spectrum that varies from $\omega^{-2/3}$ to ω^{-4} for $\omega \lesssim \omega_c$ and $\omega \lesssim \omega_c$, respectively. These features are in good general agreement with the observed characteristics of the intensity, pulse shape, and frequency spectrum of the radio pulses from pulsars. (auth)

58550 TRANSIENT GAMMA-RAY SOURCES. Apparao, Krishna M. V.; Rengarajan, T. N. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A; 73: No. 5, 257-60(May 1971).

Gamma-ray production by particles escaping from a pulsar into the surrounding nebula is considered. The gamma-ray emission decreases with time and such pulsar–nebula complexes will be observed as transient sources. (auth)

58551 OBSERVATIONS OF PULSAR POLARIZATION AT 410 AND 1665 MHz. Manchester, R. N. (National Radio Astronomy Observatory, Green Bank, W. Va. Astrophys. J., S Suppl. Ser.; 23: No. 199, 283-319(Sep 1971).

Linear-polarization parameters and mean pulse profiles with good time resolution were determined for twenty-one pulsars, with comparable data at two frequencies, 410 and 1665 MHz, for most of these. In addition, circular polarization was measured at 410 MHz for about two-thirds of the pulsars discussed. The observations show that the fractional linear polarization varies over a wide range and that the amount of polarization is generally less at 1665 MHz than at 410 MHz. Circular polarization is generally weak. However, when it does occur, it frequently reaches a peak at the center of the pulse. In those pulsars where the linear polarization is not very weak, the variation in position angle is continuous through the pulse and the same at the two frequencies. Comparison of the total-intensity profiles for a given pulsar shows that pulse components can almost always be identified at the two frequencies, but they generally have different spectral indices. The observations give strong support to the pulsar model in which the radiation originates close to the surface of the star. Depolarization effects occurring in the pulsar magnetosphere are proposed to account for the variation in fractional polarization. (auth)

58552 MODEL FOR CENTAURUS X-3. Gribbin, J. (Cambridge Univ., Eng.). Nature (London) Phys. Sci.; 233: No. 36, 18-19(6 Sep 1971).

It is stated that the discovery of periodic variations in the x-ray flux from Cen X-3 prompted reconsideration of the model of white-dwarf pulsations, which was found inadequate to explain the clock mechanism in pulsars (see Astrophys. J. Lett., 167: L.87(1971)). From the discussion it is concluded that the basic mechanism operating in Cen X-3 and the presence of periodic variations with periods of a few seconds are compatible, at least qualitatively, with the excitation of radial vibrations in an underlying white-dwarf star by the return of matter ejected in some earlier violent event. Such a model also provides a ready explanation for fluctuations in the periods found by other workers, which could be related to changes in the properties of the star caused by the impingement of gas streams and, in particular, changes in the angular momentum of the star would have a direct effort on the pulsation periods. (UK)

58553 ECLIPSING BINARY MODEL OF CYGNUS XR-1. Dolan, J. F. (Case Western Reserve Univ., Cleveland). Nature (London); 233: No. 5315, 109-10(10 Sep 1971).

Reference is made to Agrawal (Nature, 232: 38(1971)), who described interesting observations of the variable x-ray source Cyg XR-1 at energies >20 keV, and it is pointed out that these observations may be consistently interpreted in terms of the eclipsing binary model for the source originally outlined by Dolan (Space Sci. Rev., 10: 830(1970)). It is possible to interpret the observations as being caused by immersion of the blackbody source behind its non-x-radiating companion. The observations were consistent with the random arrival of photons from a nonvarying source, which in the eclipsing binary model would be identified with the x-radiating plasma surrounding the system. The relevance of some other observations made subsequent to those of Agrawal is also discussed, and it is considered that the eclipsing binary model for the variability of Cyg XR-1 seems consistent with all observations to date. (UK)

58554 OPTICAL IDENTIFICATION OF CYGNUS X-1. Murdin, P.; Webster, B. L. (Royal Greenwich Observatory, Hailsham, Eng.). Nature (London); 233: No. 5315, 110(10 Sep 1971).

It is stated that the star HD 226868 is coincident, within a 3" error, with a faint and possibly variable radio source that itself is coincident, though with a large uncertainty, with the pulsating x-ray star Cyg X-1. Information about HD 226868 obtained from the literature is summarized, together with that obtained from spectrograms taken at the Royal Greenwich Observatory with the 98-inch telescope in July to August 1971, covering the range 3600 to 5200 Å. The star appears to be a normal B0 Ib supergiant, and its distance 2.0 kpc. If the coincidence of position between the Cyg X-1 source, the radio star, and the supergiant is too strong to be by chance, the x-ray source may be a companion to the supergiant, rather than identical with it. (UK)

58555 COMPACT RADIO SOURCES IN THE GALACTIC NUCLEUS. Downes, D.; Martin, A. H. M. (Cavendish Lab., Cambridge, Eng.). Nature (London); 233: No. 5315, 112-14 (10 Sep 1971).

New observations of Sgr A, the source identified with the galactic center, are described. These observations were made in January to March 1971, with the Cambridge 1-mile telescope at 2.7 and 5 GHz, and they suggest a three-component model; they also confirmed the existence of radio structure on a scale of 10 arcsec. The relation of these compact radio sources to the infrared emission is also discussed. The maximum baseline of the observations was 25,000 λ at 5 GHz. Curves are shown for fringe amplitude and phase and for brightness distributions. Interpretations are made of the radio spectra of the components. It is suggested that Sgr A be monitored for interplanetary scintillation, which might reveal even smaller radio components. (UK)

58556 EVOLUTION AT 8 GHz OF THE LINEAR POLARIZATION OF 3C 279. Aller, Hugh D.; Olsen, Edward T. (Univ. of Michigan, Ann Arbor). Astron. J.; 76: No. 8, 671-6(Oct 1971).

The linear polarization of 3C 279 has been monitored at 8 GHz since 1965. During the single extended outburst in flux density since that time, the plane of polarization of the variable components rotated by about 100° and is now nearly parallel to the direction of the line through the centers of the two source components found by recent very long-baseline-interferometer measurements. The apparent evolution in the magnetic field structure of the emitting regions indicates that the outward moving variable components are colliding with an ambient medium. The irregular effects of this medium may account for the short-term fluctuations in the flux density since 1968. (auth)

58557 APERTURE-SYNTHESIS OBSERVATIONS OF M17 AND W49A AT 2.695 GHz. Webster, William J. Jr.; Altenhoff, Wilhelm J.; Wink, Joern E. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. J.; 76: No. 8, 677-82(Oct 1971).

The Omega Nebula (M17) and the thermal component of W49 (3C 398) were mapped with high resolution at 2.695 GHz. W49A was resolved into a clustering of components near the radio peak position, a component 2 arc min southeast of the peak position and a pair of components 1 arc min southwest of the peak position, while M17 consists of a broad component with a pair of small components superimposed. It is shown that the components in W49A are of high apparent excitation and contain a large mass of ionized hydrogen while the components of M17 are comparable with components of more normal H II regions like W3. It may be that W49A surrounds a young OB association. (auth)

58558 IDENTIFICATION OF RADIO SOURCES FROM THE OHIO SURVEY. Radivich, Mirjana M.; Kraus, John D. (Ohio State Univ., Columbus). Astron. J.; 76: No. 8, 683-5(Oct 1971).

Tentative identifications were made for 50 Ohio survey sources, many of which have flat or unusual radio spectra. About 40% of the identifications were with galaxies, 50% with stellar objects, and the remaining 10% were blank fields. (auth)

58559 CRAB NEBULA PULSAR RADIO PULSE ARRIVAL TIMES AT ARECIBO OBSERVATORY. Rankin, J. M. (Univ. of Iowa, Iowa City); Counselman III, C. C.; Richards, D. W. Astron. J.; 76: No. 8, 686-90(Oct 1971).

U.T.C. times of reception at Arecibo Observatory of 430-MHz radio pulses from the Crab Nebula pulsar are tabulated at approximately 3-day intervals from May 10, 1969 to April 6, 1971. Some arrival times recorded at various frequencies prior to May 1969 are also given. (auth)

58560 EXCITATION TEMPERATURES OF THE 18-CENTIMETER OH TRANSITIONS IN AN ABSORBING CLOUD. Manchester, R. N.; Gordon, M. A. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 169: No. 3, 507-14(1 Nov 1971).

Observations at the 18-cm OH transition frequencies were made on, and adjacent to, the strong absorption source W12. The on-source observations show that the line ratios do not vary significantly across the main 9.5 km s^{-1} feature, and they thus imply that the excitation temperatures are approximately constant. This result also shows that the OH is clumped and that the velocity dispersion observed arises from bulk motion of the clumps. In the weaker absorption between 10 and 13 km s^{-1} the excitation temperatures depart greatly from thermodynamic equilibrium and are a strong function of radial velocity. Weak, apparently normal, emission was observed both north and south of the continuum source. Part of this emission appears to originate in the same OH cloud which produces the main absorption feature. With the assumption that the properties of the OH cloud are the same at the on-source and off-source positions, this observation enables the excitation temperatures for each of the transitions to be calculated. The results show that for the OH in the strong absorption feature, all four excitation temperatures are close to the background-radiation temperature. The implications of this result are discussed, and it is concluded that the OH is most probably imbedded in a dense H I region having a kinetic temperature of 5°K or less. Optical depths, projected density, and filling factor of the OH cloud are also calculated. (auth)

58561 X RAYS FROM PUPPIS A AND THE VICINITY OF VELA X. Seward, F. D.; Burginyon, G. A.; Grader, R. J.; (and others) (Univ. of California, Livermore). Astrophys. J.; 169: No. 3, 515-24(1 Nov 1971).

A new rocket observation of the Vela region confirmed that Vel X and Pup A are strong sources of soft x rays. X rays from

Vel X come from a broad region of sky with a diameter of ≈5°. This region is centered neither on the Vel X radio source nor on the pulsar. Optical filaments lie along one edge of the x ray-emitting region. X-ray spectra were derived for Vel X and Pup A. Neither source was detectable above ~2 keV. (auth)

58562 MICROSECOND INTENSITY VARIATIONS IN THE RADIO EMISSIONS FROM CP 0950. Hankins, T. H. (Univ. of California, San Diego). Astrophys. J.; 169: No. 3, 487-94 (1 Nov 1971).

A technique for the removal of the effect of dispersion by the interstellar medium from the radio emission from pulsars was developed. Observations of the pulsar CP 0950 over a bandwidth of 125 kHz at 111.5 MHz revealed time structure as short as the reciprocal bandwidth limit of 8 microseconds. Occasional isolated subpulses of 40,000 flux units were observed. (auth)

58563 RADIOFREQUENCY DETECTION OF AN ANOMALOUS INTERSTELLAR RECOMBINATION LINE. Chaisson, Eric J.; Ball, John A. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 169: No. 3, 495-501(1 Nov 1971).

An anomalous microwave emission line discovered in the 94α spectrum toward W49 A and independently observed at 85α is shown to be the result of electronic recombination. This paper describes the observed physical characteristics of the spectral line and considers several possible origins. (auth)

58564 LIMITING MASS OF A NEUTRON STAR. Leung, Y. C. (Southeastern Massachusetts Univ., North Dartmouth); Wang, C. G. Nature (London) Phys. Sci.; 233: No. 40, 99-100 (4 Oct 1971).

In this discussion the interior of a pulsar is divided into three distinct density regions. Region 1 has a density $<5 \times 10^{11}$ g/cm^3, region 2 a density of 5×10^{11} to 10^{15} g/cm^3, and region 3 a density $>10^{15}$ g/cm^3. In region 1 the pressure is generated by an electron gas obeying the laws of atomic physics, and the semi-empirical nuclear mass formula plays an important part in the equation of state. The material in region 2 is compressed to nuclear densities and the pressure is generated by the Fermi energy of the neutron gas. Implications of this treatment are discussed. At higher densities the production of hyperons has a dramatic effect on the equation of state, and it is not clear whether these hyperons can be treated as free nucleons. There is also a limiting pressure for any density beyond which the velocity of sound would be greater than the velocity of light, and a further condition is that the equation of state should merge with the "limit of causality" line. The problem of the limiting mass of a neutron star is therefore a question of how "stiff" the equation of state should be before it is merged with the limit of causality. It is concluded that it seems unlikely that neutron stars can be more massive than, say, 0.5 $M_\odot$. (UK)

58565 COSMIC X-RAY ASTRONOMY. Adams, D. J. (Univ. of Leicester, Eng.). Contemp. Phys.; 12: No. 5, 471-93(Sep 1971).

The results obtained from observations of the celestial x radiation over the past nine years are reviewed. Emphasis is placed on the study of the discrete sources, particularly those that have been identified with astronomical objects known from optical and radio studies. The isotropic background x radiation is dealt with briefly, and the theories that account for x ray production on the atronomical scale are mentioned where applicable. Finally, the observations needed to further advance this subject are discussed. (auth) (UK)

58566 ACCURATE RADIO AND OPTICAL POSITIONS OF 3C 273B. Hazard, C. (Cambridge Univ., Eng.); Sutton, J.; Argue, A. N.; (and others). Nature (London) Phys. Sci.; 233: No. 40, 89-91(4 Oct 1971).

New measurements confirmed that 3C 273B and the associated quasi-stellar object are coincident. (auth) (UK)

58567 POSSIBLE SELECTION EFFECT IN MEASUREMENT OF QUASAR REDSHIFTS. Roeder, R. C. (Univ. of Toronto). Nature (London) Phys. Sci.; 233: No. 39, 74-5(27 Sep 1971).

The distribution of the emission line redshifts of quasars has been the subject of a number of investigations in which the power spectrum of the distribution has been computed, and attention has been drawn to the existence of sharp peaks in the distribution, at redshifts Z = 1.95 and ~0.06, with possibly others at multiples of 0.06. In any studies of the power spectrum, or comparisons of the heights of peaks in different ranges of redshift, any effects of observational selection should first be removed from the distribution, and observational data are presented that indicate that at least one selection effect can be detected in observed distributions; this affects only intervals of redshift >0.1. The implication is that the observed quasar redshift distribution does not represent the true distribution. A more accurate approximation to the true distribution should allow for an "ease of measurement effect", which is a function of redshift. The existence of such an effect also means that the heights of peaks in the redshift distribution separated by intervals greater than ~0.1 in redshift cannot be directly compared for statistical purposes. (UK)

58568 OPTICAL MONITORING OF RADIO SOURCES. III. FURTHER OBSERVATIONS OF QUASARS. Tritton, K. P.; Selmes, Rosemary A. (Royal Greenwich Observatory, Hailsham, Eng.). Mon. Notic. Roy. Astron. Soc.; 153: No. 4, 453-69(1971).

Results for 20 quasars are reported from the Herstmonceux program of optical monitoring of radio sources. New variables are 3C 175 and 3C 232, and variations suspected in earlier work were confirmed for 3C 249.1, 3C 263 and 3C 380. All quasars in the sample have now been found variable. Light curves are shown that demonstrate the difference between the "optically violently variable" sources and the other quasars. A new major outburst was recorded for 3C 454.3. No well-defined periodicities were apparent for any quasar in the sample. (auth) (UK)

58569 MODE CHANGING IN PULSAR RADIATION. Lyne, A. G. (Univ. of Manchester, Jodrell Bank, Eng.). Mon. Notic. Roy. Astron. Soc.; 153: No. 4, 27P-32P(1971).

The integrated profiles of the radio pulses from PSR 1237 + 25 and PSR 0329 + 54 were found to change abruptly at intervals of some thousands of pulses. The changes were observed mainly in the intensity profiles; the polarization characteristics were only slightly affected. (auth) (UK)

Solar Phenomena

Refer also to abstracts 58682, 58886, and 58888.

58570 (N-71-14166) LONGITUDE DISTRIBUTION OF SOLAR FLARES. Fung, P. C. W.; Sturrock, P. A.; Switzer, P.; Van Hoven, G. (Stanford Univ., Calif. Inst. for Plasma Research). Nov 1970. Contract F44620-69-C-0008. 23p. (NASA-CR-111735; SU-IPR-393). NTIS.

Statistical tests, based on the maximum likelihood method, were performed on flare series extending over several years. If all flares in each plage region are taken into account, a rich spectrum is obtained. If one carries out a similar analysis of a reduced flare series, which includes at most one flare from each plage region, the spectrum is almost devoid of structure, and what structure does remain is not statistically significant. The inference is that solar activity does not display genuine rigid rotation modulation, but that repeated events from individual centers of activity yield modulation that may be mistaken for rigid-rotation modulation. A test for correlation between reduced flare series for the northern and southern hemispheres gives no significant correlation. This test therefore yields no support to the hypothesis that solar activity is modulated by planetary effects. (auth) (STAR)

58571 FORMATION OF PROMINENCES. Pikel'ner, S. B. (Shternberg State Astronomical Inst., Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 276-8(Sep-Oct 1971).
Translated from Astron. Zh.; 48: No. 2, 357-9(Mar-Apr 1971).

The formation of prominences is usually linked to the thermal instability of the radiatively cooled corona. Energy losses through heat conduction to the chromosphere and production of solar wind also play a significant role in the thermal balance of the corona, however. The magnetic field supporting the prominence must be shaped as an arc with a pit at the top, it appears, as required by hydrodynamic stability conditions. Heating would be minor in such a pit, since Alfvén waves and slow waves do not propagate across the lines of force, and fast waves become attenuated through refraction. The temperature difference is responsible for the stream along the lines of force, while the gas flows into the pit to condense there. Calculations yield the change in parameters along the tube of force, and the magnitude of the gas stream. It takes one to two days for the prominence to form, with the excess of gas trickling down into the chromosphere. (auth)

58572 PROFILES OF THE CORONAL LINES $\lambda\lambda$ 5303 Å, 6374 Å BASED ON LARGE (53 CM) CORONOGRAPH OBSERVATIONS. Makarova, V. V.; Makarov, V. I.; Nilol'skii, G. M. (State Astronomical Observatory, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 279-83(Sep-Oct 1971).
Translated from Astron. Zh.; 48: No. 2, 360-4(Mar-Apr 1971).

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Profiles of lines were constructed for different distances from the solar limb from out-of-eclipse plates taken of the coronal lines λλ 5303 and 6374 Å on the 53-cm coronograph in 1967–1969. The profiles exhibited a Doppler shape, within the limits of error of the observations. Nonthermal velocities are ≈20 km/sec. (auth)

58573 DYNAMICAL PROCESSES RESPONSIBLE FOR ORIGIN OF CORONAL FORMATIONS. Guseinov, R. E. (Shemakha Astrophysical Observatory, Baku). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 284-9(Sep-Oct 1971).

Translated from Astron. Zh.; 48: No. 2, 365-72(Mar-Apr 1971).

Arguments are adduced in support of the view that a coronal flare—an active or quiescent prominence—can originate as a result of compression of the coronal plasma with a longitudinal magnetic field in response to pressure exerted by the "magnetic wall," depending on the initial physical conditions (temperature, density, magnetic-field strength) in the medium undergoing compression and the compression rate. The differential equation for the energy balance is derived (without assuming adiabatic compression). The final density in the tube of force, the initial internal longitudinal field, the maximum internal longitudinal field, and time variations of the field are estimated. These estimates are found to be in excellent agreement with data on coronal flares, and active and quiescent prominences. Arguments on some aspects of emission connected with coronal flares are also advanced. (auth)

58574 E-22 FRENCH EXPERIMENT ABOARD THE OGO-5 AMERICAN SATELLITE. Bertaud, J. L. (Centre National de la Recherche Scientifique, Verrieres-le-Buisson, France). Rech. Spatial.; 10: No. 3, 5-8(May 1971). (In French).

Results obtained from geocoronal observations made during the E-22 French experiment on extraterrestrial Lyman–alpha emission and investigations of the hydrogen envelope surrounding comets are presented. (France)

58575 ORIGIN OF ORGANIC MATTER IN EARLY SOLAR SYSTEM. III. AMINO ACIDS: CATALYTIC SYNTHESIS. Yoshino, Daisuke; Hayatsu, Ryoichi; Anders, Edward (Univ. of Chicago). Geochim. Cosmochim. Acta; 35: No. 9, 927-38(Sep 1971).

When OC, H_2 and NH_3 are allowed to react at 200 to 700°C in the presence of nickel, alumina, or clay catalysts, amino acids are found among the products in yields of 0.01 to 0.1%. Purines, pyrimidines, and hydrocarbons are also formed. Identifications were made by use of an amino-acid analyzer. Although some contamination had occurred, the following amino acids appear to have been definitely synthesized: glycine, α-alanine, β-alanine, sarcosine, aspartic acid, glutamic acid, arginine, histidine, lysine, and ornithine. Evidence is less conclusive for leucine, isoleucine, valine and proline. (auth)

58576 ORIGIN OF ORGANIC MATTER IN EARLY SOLAR SYSTEM. IV. AMINO ACIDS: CONFIRMATION OF CATALYTIC SYNTHESIS BY MASS SPECTROMETRY. Hayatsu, Ryoichi (Univ. of Chicago); Studier, Martin H.; Anders, Edward. Geochim. Cosmochim. Acta; 35: No. 9, 939-51(Sep 1971).

Catalytic synthesis of the following amino acids from CO, ND_3, and D_2 was confirmed mass spectrometrically: glycine, alanine, aspartic and glutamic acids, histidine, lysine, ornithine, and tyrosine. Contamination was ruled out by use of deuterated reactants. It appears that this reaction (a variant of the Fischer–Tropsch synthesis) can produce most of the amino acids seen in meteorites, along with hydrocarbons, purines and pyrimidines. It may have been an important process for the production of prebiotic organic matter in meteorites and planets. (auth)

58577 MOLECULAR SPECTRUM OF SUNSPOT UMBRAE. Sotirovskii, P. (Meudon Observatory, France). Astron. Astrophys.; 14: No. 2, 319-36(Sep 1971).

By means of spectrographic analysis the molecular spectra in three sunspot umbrae were studied. The first step was to try to identify all the molecular lines in the spectral range 4900 to 6450 Å using the method of coincidences. Because of the very high number of spectral lines per Ångström, this method may lead to spurious results; thus it was necessary to make various checks based on line or band intensities. Fourteen molecules were studied; three of them (CN, MgH, and TiO) were extensively analyzed and provided reliable information about the rotational temperatures (3000°K in the largest umbra). In the same way an empirical curve of growth was obtained from the MgH lines that allowed the Mg isotopic ratios to be estimated. The last step was to compute the equivalent widths of molecular lines using Hénoux's sunspot model and to compare the calculations with the observations; thus it was possible to confirm the model and also to evaluate several molecular parameters which were previously unknown (TiO oscillator strengths in the α system) or doubtful (MgH $^2\Pi - {}^2\Sigma$ system oscillator strengths). It is pointed out that all the results are consistent with a microturbulence velocity ξ = 1 km/s in the largest sunspot. (auth)

58578 INTERPLANETARY HYDROGEN CONE AND ITS SOLAR-CYCLE VARIATIONS. Fahr, H. J. (Institut fuer Astrophysik und Extraterrestrische Forschung, Bonn). Astron. Astrophys.; 14: No. 2, 263-74(Sep 1971).

The motion of interstellar hydrogen particles within the solar system was investigated taking into account the thermal motions of the particles. It is shown that the particle density generally decreases with decreasing distances from the Sun due to particle losses by euv ionizations and charge-transfer reactions. Solely in the direction opposite to the approach of interstellar matter a cone of enhanced hydrogen densities is produced. Within this cone the focusing effect of the solar gravitational field gives rise to a density increase of interstellar hydrogen by up to a factor of 6 with respect to the density n_0 outside of the solar system. The densities resulting within the cone and the angular profile width of the cone strongly depend on the temperature of the interstellar gas. Measurements of the intensities of the Lyman-alpha backscatter radiation from the region of this hydrogen cone should not only reveal the actual geometry of the cone, but should directly permit a deduction of this temperature which is unknown so far. Furthermore, it is shown that the geometry of the hydrogen cone is influenced by the radiation pressure of the solar Lyman-alpha radiation which varies within the solar cycle. Consequently, it is to be expected that the cone changes its profile during the 11-year solar activity cycle. The hydrogen cone leads to a density-dependent and temperature-dependent embayment of the magnetic shockfront in a direct which coincides with the location of the sidereal intensity maximum of galactic cosmic rays. (auth)

58579 PROPAGATION OF A SPECTRUM OF ACOUSTIC WAVES IN THE SOLAR ATMOSPHERE. Ulmschneider, Peter (Univ., Wuerzburg, Ger.). Astron. Astrophys.; 14: No. 2, 275-82(Sep 1971).

The propagation of acoustic waves, their transformation into shock waves and their dissipation was computed on basis of the Harvard Smithsonian Reference Atmosphere (HRA) for the Sun. Acoustic frequency spectra of Stein (1968) were used and the effect of radiative damping included. Good agreement was found between the heating produced by these waves and the computed radiative losses in the chromosphere. Coronal heating proved more difficult to explain. (auth)

58580 SOLAR TRANSITION LAYER AND SOLAR ACTIVE REGIONS. Reimers, D. (Univ., Kiel). Astron. Astrophys.; 14: No. 2, 198-202(Sep 1971).

An empirical minimum equator model of the solar transition layer and inner corona was constructed using observations of the solar radio and ultraviolet spectra and of the white and the monochromatic corona. The sudden temperature rise in the transition layer determined from ultraviolet spectra e.g., by Dupree and Goldberg (1967) was confirmed by observations of the solar radio spectrum. A coronal temperature of $(1.4 \pm 0.1) \times 10^6$°K, an electron density in agreement with the absolute scale of v. d. Hulst (1950), and a coronal abundance log N_{Si} = 7.56 ± 0.1 were derived for transforming Pottasch's (1967) relative scale of abundances into an absolute one. The one-parameter model of solar-active regions (Reimers, 1971), which establishes relations between the temperature and density of the corona and the temperature gradient in the solar-transition layer, was confirmed by the extreme-ultraviolet spectroheliograms from OSO IV and by radio spectra of active regions as well as by observations of coronal rays and condensations. Thus, a very simple empirical method is obtained for determining the transport of mechanical energy into the corona. In very strong active regions the mechanical energy flux is enhanced by factors up to ≈20, which corresponds to $\approx 10^7$ erg/cm^2 s. (auth)

58581 ANGULAR MOMENTUM AND SHORT-TERM DIRECTIONAL FLUCTUATIONS OF THE SOLAR WIND FROM VELA 3 DATA. Hardorp, Johannes (State Univ. of New York, Stony Brook). Astron. Astrophys.; 14: No. 2, 210-14(Sep 1971).

From recently published lists of detailed solar-wind observations by the Vela 3 satellites, it is shown that the Sun's loss of angular momentum can be derived from time averages of solar-wind density, velocity, and direction without danger of statistical bias. Brandt's result of an e-folding time for solar spin-down of the order of the age of the Sun is therefore confirmed. Directional fluctuations of the solar wind on a time scale of 3 hours or shorter show a dispersion of 1° only, in contrast to the 3° dispersion of slow variations. Since tail rays of comet Morehouse 1908 III display wiggles with a directional dispersion of 0.7°, it is concluded that the solar wind acts on the inner parts of ionic comet tails in a direct way. (auth)

58582 LARGE-SCALE PROPERTIES OF THE INTERPLANETARY MAGNETIC FIELD. **Schatten, Kenneth H. (Goddard Space Flight Center, Greenbelt, Md.). Rev. Geophys. Space Phys.; 9: No. 3, 773-812(Aug 1971).**

Knowledge of the large-scale properties of the interplanetary magnetic field is reviewed. The early theoretical work of Parker is presented, along with the observational evidence supporting his Archimedes spiral model. The variations present in the interplanetary magnetic field from the spiral angle are related to structures in the solar wind. The causes of these structures are found to be either nonuniform radial solar-wind flow or the time evolution of the photospheric field. The coronal magnetic models are related to the connection between the solar magnetic field and the interplanetary magnetic field. The direct extension of solar field–magnetic nozzle controversy is discussed, along with the coronal magnetic models. The effect of active regions on the interplanetary magnetic field is discussed with particular reference to the evolution of interplanetary sectors. The variation of the interplanetary magnetic-field magnitude is shown throughout the solar cycle. The percentage of time the field magnitude is greater than 10 γ is shown to closely parallel sunspot number. The suggested influence of the Sun's polar field on the interplanetary field and alternative views of the magnetic-field structure out of the ecliptic plane are presented. In addition, a variety of significantly different interplanetary-field structures is discussed. 44 references. (auth)

58583 NEW OBSERVATIONS OF SATELLITE LINES IN THE SOLAR X-RAY SPECTRUM. **Parkinson, J. H. (Univ. of Leicester, Eng.). Nature (London) Phys. Sci.; 233: No. 38, 44-5(20 Sep 1971).**

Several weak satellite lines were observed for the first time in solar x-ray spectra obtained from four Bragg crystal spectrometers launched on a Skylark rocket on Dec. 6, 1970 from Sardinia. The proximity of these lines to the H3-like $1S^2-1S\ 2p$ lines indicated that they were all transitions of type $1S^2\ nl-1S\ 2p\ nl$. The He-like line systems of 0 VII, Ne IX, Mg XI, and Si XIII were observed, and the Ne and Mg spectra are reproduced, indicating the resonance, intercombination, and forbidden lines. The intensities of the respective resonance lines are discussed; the results strongly support the assumption of dielectronic recombination as the principal mechanism for the formation of the n = 2 satellite lines. (UK)

58584 PHYSICS OF SUNSPOTS. PART IV. **Jakimiec, Jerzy (Astronomical Observatory, Wroclaw). Postepy Astron.; 19: No. 3, 199-213(1971). (In Polish).**

The problem of constructing complete, hydromagnetic models of the photospheric layers of a spot is considered, taking all relevant observational data into account. Much attention is devoted to the question of determining the distribution of the magnetic forces in the spot. (auth)

58585 OBSERVATIONAL DATA ON THE SOLAR WIND. **Sroczynska, Magdalena (Astronomical Observatory, Warsaw). Postepy Astron.; 19: No. 3, 215-23(1971). (In Polish).**

A short review of the observational data on solar wind (near the orbit of the Earth) is given. (auth)

58586 FLOCCULE THEORY AND PLANETARY FORMATION. **Aust, C.; Woolfson, M. M. (Univ. of York, Eng.). Mon Notic. Roy. Astron. Soc.; 153: No. 3, 21P-25P(1971).**

A three-dimensional model of the formation of planets by the floccule theory was examined with the aid of a computer. It was found to lead to a nonplanar system with many proto-planets in retrograde orbits. (auth) (UK)

58587 EFFECT OF SCATTERED LIGHT ON THE FACULA-TO-PHOTOSPHERE CONTRAST. **Pande, M. C.; Tripathi, B. M.; Guar, V. P. (Uttar Pradesh State Observatory, Naini Tal, India). Bull. Astron. Inst. Czech.; 22: No. 4, 161-2(1971).**

The measured facula-to-photosphere contrast in the continuum radiation corrected for the scattered light should yield a hotter average facula model than the models derived without such a correction. (auth)

58588 RELATION BETWEEN ELECTRIC CONDUCTIVITY IN FACULAE AND IN THE BILDERBERG MODEL OF THE PHOTOSPHERE. **Kopecky, M.; Soyturk, E. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech.; 22: No. 4, 154-6(1971).**

The value of the electric conductivity at different optical and geometrical depths in the Bilderberg model of the photosphere and low chromosphere and in the model of faculae is given. In the case of inhomogeneous electric conductivity in the active regions of the Sun, relatively complicated systems of electric currents must exist in the active regions. (auth)

58589 DEPENDENCE OF MOLECULAR DISSOCIATION EQUILIBRIUM ON MAGNETIC FIELD STRENGTH IN SUNSPOTS. **Gaur, V. P.; Pande, M. C.; Tripathi, B. M.; Joshi, G. C. (Uttar Pradesh State Observatory, Naini Tal, India). Bull. Astron. Inst. Czech.; 22: No. 4, 157-60(1971).**

It is shown that the total number of CO, CN, C_2, OH, NH, and CH molecules varies significantly with magnetic field strength in sunspots. The equivalent widths of first two overtone lines of CO belonging to the 0–2 vibration–rotation band as a function of magnetic field strength are also given. It appears that up to 2500 gauss the equivalent widths change linearly with magnetic field strength. (auth)

58590 DIRECT OBSERVATION OF COSMIC-RAY ENERGY LOSSES. **Gleeson, L. J. (Monash Univ., Clayton, Australia); Palmer, I. D. Astrophys. Space Sci.; 12: No. 1, 137-46(Jul 1971).**

During the decay of solar cosmic-ray events, cosmic rays with kinetic energies of about 1 MeV are convected outward with the solar wind. It is shown that, with currently available observations, it should be possible to demonstrate directly the energy losses that are occurring. Observations from two spacecraft on the same heliocentric radial line are required. Observations from Venera-4 and Imp-F were used. A simple and direct demonstration would be provided by the observation of nearly mono-energetic pulses convected between the two spacecraft, but no such pulses were found to be present. A second method depends upon observing the ratio of the integral fluxes at the two spacecraft and comparing this with the value predicted by theory. The relevant theoretical analysis is given. It is shown that, in order to discriminate between energy-loss processes, the spacecraft must be well separated. For spacecraft at Earth's orbit and the orbit of Venus the integral-flux ratio predicted with energy loss due to adiabatic deceleration is a factor of three higher than that predicted with no energy loss. Comparisons of integral-flux ratios for two events observed on spacecraft separated by approximately 0.1 AU gave inconclusive results. In view of the importance of energy-loss processes in the propagation of cosmic rays it is suggested that others with access to relevant data might continue this investigation. (auth)

58591 PLANETARY FORMATION FROM CHARGED BODIES. **Williams, I. P. (Queen Mary Coll., London). Astro phys. Space Sci.; 12: No. 1, 165-71(Jul 1971).**

The suggestion of Sarvajna that a charged body that has been ejected from the Sun can be captured in orbit because of electromagnetic effects was reinvestigated. It was concluded that the charge assumed by Sarvajna is too high by many orders of magnitude. An alternative scheme is proposed in which the charge requirement is much more realistic, and it is shown that this scheme is feasible. (auth)

58592 SOLAR FLARE PREDICTION. **Brailovskii, V. L.; Brailovskaya, I. Yu. (Moscow State Univ. Inst. of Electrically Controlled Machines, Moscow). Dokl. Akad. Nauk SSSR; 198: No. 2, 319-22(11 May 1971). (In Russian).**

A number of compilations of data on solar activity in 1966 were used in a study of solar-flare prediction by statistical methods on a computer. The data included total sunspot area of a given group, the area of the maximum spot within it, and the number of spots in a group. For each flare, the moment of its beginning and ending, heliographic coordinates, area, and brightness were entered. Various functions were designed from these data for handling by computer: previous history of flare activity, spot groups as characterized by the logarithm of the number of spots, breaking-up of groups, inequality of area distribution, and the effect of neighboring groups of spots. The authors evaluate this work as the first step of their development of solar-flare prediction. (K.S.W.)

58593 ABUNDANCE OF CHLORINE IN THE SUN. **Lambert, D. L. (Univ. of Texas, Austin); Mallia, E. A.; Brault, J. Solar Phys.; 19: No. 2, 289-96(Sep 1971).**

A low-noise photoelectric scan which includes the predicted position of the Cl I transition $4s\ ^4P_{5/2}2-4p\ ^4D^0_{5/2}$ provides inconclusive evidence for the presence of the line in the solar photospheric spectrum. An upper limit log N(Cl) $\leq$ 5.5 is derived. It is pointed out that the fundamental vibration rotation band of HCl at 3.3 μ should be detectable in the sunspot spectrum unless log N(Cl) < 4.6. Sunspot spectra may also provide the isotopic abundance ratio $N(^{35}Cl)/N(^{37}Cl)$. A new derivation of the chlorine abundance for the Orion nebula is presented: log N(Cl) $\approx$ 5.8. It is suggested that a cosmic abundance log N(Cl) = 5.5 to 5.8 be adopted. (auth)

58594 POWER SPECTRUM ANALYSIS OF GRANULAR INTENSITY FLUCTUATIONS AND VELOCITIES. Reiling, H. (Univ., Goettingen, Ger.). Solar Phys.; 19: No. 2, 297-313 (Sep 1971).

An exceptionally highly resolved spectrogram (obtained by Livingston at Kitt Peak) was used to derive rms values for both the intensity fluctuations in the continuum and the granular velocities in the Ba II line λ5853.69 by means of the power spectrum analysis. The main results were: (1) a corrected rms value for the intensity fluctuations of 3.8%; (2) a nearly constant power level in the one-dimensional power spectrum per unit wave number within the range 0.00018 to 0.01 km^{-1} ($\triangleq$34000 to 600 km); (3) a corrected rms value for the granular velocities of ~1 km/s. The behavior of the asymmetry of the Ba II line in individual "bright" and "dark" continuous streaks can be explained by a superposition of two shifted symmetric line profiles originating from pure granular and intergranular regions, respectively. The impurity of "dark" and "bright" streaks amounted to less than ~10%, the mean relative velocity of granular and intergranular regions being again ~1 km/s. The microturbulence in the intergranular regions is indicated to be larger than in the granular ones. (auth)

58595 INTERFEROMETRIC MEASUREMENTS OF 142 SOLAR WAVELENGTHS. O'Brien, James E. (Georgetown Coll. Observatory, Washington, D. C.). Solar Phys.; 19: No. 2, 314-22(Sep 1971).

The wavelengths of 142 solar absorption lines, in light taken from the center of the solar disk, and in the wavelength region 4675 to 6275 Å, were determined by interferometric comparison with the standard wavelengths of ^{198}Hg. A Fabry–Pérot interferometer was crossed with a high-dispersion, Wadsworth-type spectrograph by a method similar to that used at Allegheny and Mount Wilson Observatories in the original determinations of the IAU solar wavelength standards of 1928. The wavelengths of 68 solar iron lines were compared with hollow-cathode wavelengths, and differences between the resulting wavelength shift and that predicted by relativity theory calculated. (auth)

58596 ABSOLUTE INTENSITY CALIBRATIONS OF SOLAR K-LINE PROFILES. Pasachoff, Jay M. (California Inst. of Tech., Pasadena). Solar Phys.; 19: No. 2, 323-9(Sep 1971).

Individual K-line profiles from elements of fine structure on the surface of the Sun were calibrated absolutely. The continuum calibrations of Labs and Neckel and of Houtgast and Namba were considered, and the average K-profile was scaled to that of White and Suemoto. The ranges of intensities across a high-resolution spectrogram were tabulated for various parts of the line profile. Although the spatially-averaged value for K_3 of 4.2% of the continuum corresponded to a brightness temperature of 4155 K, minimum and maximum values were 3980 and 4360 K, respectively. Similarly, K_{2v} ranged from 4200 to 4560 K, and K_{2r} from 4180 to 4460 K in small elements about 1 arc sec across. (auth)

58597 ISOTOPES OF MAGNESIUM IN THE SOLAR ATMOSPHERE. Boyer, R.; Henoux, J. C.; Sotirovski, P. (Observatoire de Paris, Meudon, France). Solar Phys.; 19: No. 2, 330-7(Sep 1971).

MgH $A^2\Pi - X^2\Sigma$(0.0), (1.1), (2.2), (0.1), and (1.2) absorption bands in a sunspot spectrum were analyzed. By two different methods, which are almost independent of the estimated value of the correction for stray light, the solar isotopic ratios of magnesium were determined. These ratios were equal to the terrestrial ones — ^{24}Mg : ^{25}Mg : ^{26}Mg = 80 : 10 : 10. (auth)

58598 TWO-DIMENSIONAL OBSERVATIONS OF THE VELOCITY FIELD IN AND AROUND SUNSPOTS. Sheeley, N. R. Jr. (Kitt Peak National Observatory, Tucson, Ariz.); Bhatnagar, A. Solar Phys.; 19: No. 2, 338-46(Sep 1971).

Doppler spectroheliograms of sunspots and their surroundings were obtained with a spatial resolution approaching one second of arc and a time resolution of 20 s per frame. Observations of 5 sunspots, located 18°, 45°, 56°, 60°, and 72° from the disk center, respectively, showed considerable long-lived fine structure and, in particular, indicated the following: (1) The Evershed outflow terminated in spoke-like structures that constitute the ragged outer boundary of the penumbra. Some of these spokes extended more than 8000 km beyond the average outer boundary. (2) Although there was considerable long-lived fine structure of both Doppler polarities in the extra-penumbral photosphere, the spatially-averaged horizontal flow was outward for roughly 10,000 km beyond the outer boundary of the penumbra. This extra-penumbral velocity field was distinct from the Evershed flow, and, in particular, did not represent its extension beyond the end of the penumbral spokes. Although these results are based on observations of relatively few sunspots, they do suggest that if magnetic fields are carried outward from sunspots by material motions, then these motions are more like the supergranulation than an extension of the Evershed velocity. (auth)

58599 ELECTRON DENSITIES DERIVED FROM LINE INTENSITY RATIOS: BERYLLIUM ISOELECTRONIC SEQUENCE. Munro, Richard H.; Dupree, A. K.; Withbroe, George L. (Harvard Coll. Observatory, Cambridge, Mass.). Solar Phys.; 19: No. 2, 347-55(Sep 1971).

A direct method for determining electron densities from emission-line intensities of ions in the beryllium isoelectronic sequence is described and then applied to the analysis of extreme ultraviolet C III and O V spectra from both quiet and active areas in the solar transition region. The results are consistent with a value of $N_eT_e = 6 \times 10^{14}$ cm^{-3} K for the quiet Sun at temperatures of 5×10^4 to 3×10^5 K. Electron densities are approximately five times greater in active regions than in the quiet Sun. (auth)

58600 SOFT SOLAR X RAYS AND SOLAR ACTIVITY. V. RELATION OF THE COURSE OF SOFT X-RAY FLUCTUATIONS TO THE COURSE OF SOLAR ACTIVITY, 9 MARCH, 1967–18 MAY, 1968. Teske, Richard G. (Univ. of Michigan, Ann Arbor). Solar Phys.; 19: No. 2, 356-78(Sep 1971).

Soft solar x rays in the wavelength interval 8 to 12 Å were observed from OSO III. The totality of the observations that were made between March 9, 1967 and May 18, 1968 is summarized graphically and compared to the course of solar activity as observed at other wavelengths, with particular emphasis upon visible activity. (auth)

58601 SOLAR ROTATION: DIRECT EVIDENCE FROM PROMINENCES FOR A WESTWARD WIND. Livingston, W. (Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys.; 19: No. 2, 379-83(Sep 1971).

Hα and K-line spectra of quiescent prominences, taken with the slit placed normal to the limb, commonly reveal a gas streaming (5 to 50 km/s) that is peculiar to the upper edge of these objects. On the average this streaming is unidirectional and consistent with a hypothetical east–west wind. (auth)

58602 ABUNDANCE OF HELIUM IN PROMINENCES AND IN THE CHROMOSPHERE. Hirayama, Tadashi (Tokyo Astronomical Observatory). Solar Phys.; 19: No. 2, 384-400(Sep 1971).

The abundance of helium relative to hydrogen was spectroscopically determined in prominences and in the chromosphere by using 1952, 1958, 1962, and 1966 eclipse data. Care was taken in the intensity calibration of emission lines, the self-absorption, and the departure from local thermodynamic equilibrium. It was found from the line profiles and intensities of prominences and the chromosphere that the neutral helium lines were emitted in the metal–hydrogen emitting region where the kinetic temperature is low enough, 6000 ~ 8000 K, so that only the ionization due to uv radiation from the corona can explain the intensity of neutral helium emission. It was also found that the intensity ratio of He I 3888.65 to Hα 3889.05 increased towards the upper boundaries of prominences and of the chromosphere and that it approached a universal limiting value, both in various prominences or in the chromosphere, where it was considered that the ionization of neutral helium and hydrogen is nearly complete. From these facts the helium to hydrogen number ratio was found to be 6.5 ± 1.5%. A new schematic model of the chromosphere is presented where spicules have no hot region of emitting neutral helium lines. Here it is suggested that the kinetic temperature of spicules, 6000 ~ 8000 K, would be primarily determined by the radiation temperature of the corona and the transition region beyond the Lyman continuum of hydrogen which happens to be around those temperatures. (auth)

58603 ENERGY BALANCE IN COOL QUIESCENT PROMINENCES. Poland, A.; Anzer, U. (National Center for Atmospheric Research, Boulder, Colo.). Solar Phys.; 19: No. 2, 401-13(Sep 1971).

The energy balance for cool quiescent prominences was examined using a 6000-km, 6000 K isothermal slab model prominence with a density gradient dictated by a modified Kippenhahn–Schlüter model. The model was irradiated from both sides by the coronal, chromospheric, and photospheric radiation fields. The radiative transfer problem was solved in detail for the Lyman continuum and Hα to determine the net radiative energy loss for hydrogen. An estimate of the energy loss for Ca II H and K indicated that this source of energy loss is unimportant when compared with the hydrogen radiation. The radiative energy loss is easily balanced by the conductive energy gain from the corona. The only difficulty with the model was that the total hydrogen density must be of the order of $3 \times 10^{12}/cm^3$ to match the $n = 2$ population density of $5 \times 10^4/cm^3$ obtained from observation. To support a prominence of this density and a thickness of 6000 km against gravity requires magnetic fields of the order of 20 G which is much higher than the average magnetic field in quiescent prominences deduced from limb observations. Two possible explanations for this discrepancy are given. (auth)

58604 HELIUM RADIATION IN PROMINENCES. Yakovkin, N. A.; Zeldina, M. Yu. (University Observatory, Kiev). Solar Phys.; 19: No. 2, 414-30(Sep 1971).

It is shown that the emission of quiescent and loop prominences in the helium D_3 line and in the 4686 Å line of He^+, respectively, occurs at low temperatures —of the order of 7000 K. The ionization of neutral helium is produced by short-wave solar radiation, which is absorbed in the outer layers of filaments composing a prominence. The population of helium triplet levels in prominences is determined by recombinations and subsequent resonance scattering of photospheric radiation. Transitions from triplet to singlet levels caused by electron collisions considerably reduce the line brightness. Emission of ionized helium in the 4686 Å line arises in prominence surface layers as well. In quiescent prominences the emission is very faint and is due to recombination; the second ionization is caused by the far ultraviolet radiation. In flare-like events ionized helium emits due to charge-exchange collisions. The symmetrical resonance charge-exchange of α particles is caused by helium ions in corpuscular streams probably generated in photospheric layers. Due to increased radiation losses the temperature of the prominence under the action of the stream is negligibly increased. With a stream density equal to 5×10^8 cm^{-3} and velocity 300 km/s the theoretical intensity of the 4686 He^+ line is some hundreds of microångströms and agrees with observations of Goldberg–Rogozinskaya (1962, 1965) and others. (auth)

58605 ABUNDANCE OF CALCIUM IN THE SOLAR CORONA. Fisher, Richard R. (Univ. of Hawaii, Honolulu). Solar Phys.; 19: No. 2, 431-5(Sep 1971).

Measured values for the total intensity of the continuum and the ratio of integrated intensities $I(\lambda 5694)/I(\lambda 5446)$ were used to estimate the fraction of electrons along the line of sight contributing to the excitation of Ca XV. This estimate of electron density along with an estimate of the dimension of the emitting region was used to find a value of the abundance of Ca in the solar corona. The estimated abundance was $\log N_{Ca}/N_H = -4.35$. (auth)

58606 MONOCHROMATIC OBSERVATIONS OF A CORONAL LOOP. Fisher, Richard R. (Univ. of Hawaii, Honolulu). Solar Phys.; 19: No. 2, 436-9(Sep 1971).

An isophotal map of a small coronal loop, obtained from a coronagraph observation through a solid Fabry–Perot interferometer, was used to estimate the variation of emission per unit volume and the pressure gradient at the top and sides of the loop. The magnitude of the magnetic field necessary to maintain the estimated pressure gradients was found to be $|\bar{H}^2| = 30$ G^2. (auth)

58607 DISTRIBUTION OF MATERIAL AS A FUNCTION OF TEMPERATURE IN THE POST-FLARE LOOP SYSTEM OF AUGUST 12, 1970. Fisher, Richard R. (Univ. of Hawaii, Honolulu). Solar Phys.; 19: No. 2, 440-50(Sep 1971).

Observations of the post-flare loop system formed after the east limb proton flare of August 12, 1970 include (a) sets of filtergrams from which photographic subtractions were constructed and (b) spectra from which a distribution of electron density as a function of temperature for three coronal regions is derived. The filtergrams show no indications of radial velocities in excess of 80 km/s. The spectra indicate an increase in density at the tops of the loops with most of the material at a relatively cool temperature: $N_e \simeq 6.0 \times 10^{10}$, $N = 3 \times 10^5$ K. The distribution functions obtained for areas just above and just below loops indicate a lower electron density and the presence of material at high temperatures, $N_e \simeq 2.0 \times 10^{10}$ and $T \simeq 2.6 \times 10^6$ K (above the loops) and $T_e > 4.4 \times 10^6$ K for material below the loops. (auth)

58608 MASS MOTIONS IN A FLARE SPRAY. McCabe, Marie K. (Univ. of Hawaii, Honolulu). Solar Phys.; 19: No. 2, 451-62(Sep 1971).

High-velocity Hα ejections were observed in association with an important solar flare on March 12, 1969, and simultaneously with Type II followed by Type IV radio emission detectable to 3 to 4° solar radii ($R_\odot$) from the center of the Sun. From a sequence of Hα coronagraph photographs, trajectories and velocity determinations were made for fragments of the flare spray which was visible to a distance of 2 $R_\odot$. The temporal and spatial relationship between the optical and radio events is discussed. The mass motions appear to be controlled by the gravitational field while the fragments move in the direction of the open magnetic field lines. (auth)

58609 MAGNETIC FIELDS, BREMSSTRAHLUNG, AND SYNCHROTRON EMISSION IN THE FLARE OF OCTOBER 24, 1969. Zirin, H. (California Inst. of Tech., Pasadena. Carnegie Institution of Washington, D. C.); Pruss, Gail; Vorpahl, Joan. Solar Phys.; 19: No. 2, 463-71(Sep 1971).

An impulsive flare October 24, 1969 produced two bursts with virtually identical time profiles of 8800-MHz emission and x rays above 48 keV. The two spikes of hard x rays corresponded in time to the times of sharp brightening and expansion in the Hα flare. The first burst was not observed at frequencies below 3000 MHz. This cutoff was ascribed to plasma cutoff above the low-lying flare. A model of the flare based on Hα observations at Big Bear showed that the density of electrons with energy above 10 keV was 5×10^7 if the field density was 10^{11}. The observed radio flux would be produced by this electron distribution with the observed field of 200 G. The Hα emission accompanying the hard electron acceleration was presumed due to excitation of the field atoms by the hard electrons. (auth)

58610 FARADAY ROTATION DISPERSION AND THE DISTRIBUTION OF POLARIZATION CHARACTERISTICS OF TYPE III BURSTS. Fokker, A. D. (Univ., Utrecht). Solar Phys.; 19: No. 2, 472-9(Sep 1971).

Some results on the distribution of polarization characteristics of Type III bursts obtained by Chin, Lusignan, and Fung (1971) are analyzed in terms of the effects of Faraday-rotation dispersion on fully polarized signals with small axial ratios of the polarization ellipse. (auth)

58611 PLANETARY INFLUENCES ON THE LARGE-SCALE DISTRIBUTION OF SOLAR ACTIVITY. Ambroz, P. (Observatory, Ondrejov, Czech.). Solar Phys.; 19: No. 2, 480-2(Sep 1971).

Recently a conspicuous correlation between the degree of solar activity and the value of tidal force due to planets was published by Bigg and Mulhall (1967). These results may be accepted as a good reason for a working hypothesis about the possible contribution of extrasolar influence on the solar activity formation. The aim of the present short note was to check the reality of existence of a spatial relationship between the solar surface area being influenced by the planetary tidal force and the distribution of calcium flocculi. (auth)

58612 SOLAR LONGITUDE DEPENDENCE OF PROTON-EVENT DELAY TIME. Barouch, E.; Gros, M.; Masse, P. (CEN de Saclay, Gif-sur-Yvette, France). Solar Phys.; 19: No. 2, 483-93(Sep 1971).

The relationship between heliographic longitude and the delay between flare occurrence and solar proton observation was studied using results obtained aboard HEOS A1 during 1969. The result obtained differed from previous findings. This was ascribed to the formation of a long-lived magnetic field configuration close to the Sun associated with a particular group of active regions. (auth)

58613 VELOCITY AND TEMPERATURE OF THE SOLAR WIND FROM DATA OBTAINED USING THE MODULATION TRAP ON INTERPLANETARY STATION VENERA-3. Gringauz, K. I.; Zastenker, G. N.; Khokhlov, M. Z. Cosmic Res. (USSR) (Engl. Transl.); 8: No. 6, 868-71(Nov-Dec 1970).

Translated from Kosm. Issled.; 8: No. 6, 948-51(Nov-Dec 1970).

The modulation charged-particle trap carried by Venera-3 was used to carry out numerous measurements of the energy spectra of the ionic component of the solar wind in the period from Nov. 1965 through Jan. 1966. These energy spectra were used to determine the temperature of the ions and the velocity of the solar wind by comparing them with trap readings calculated in advance on the basis of a stipulated model of the wind. (W.D.M.)

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58614 SPECTRAL STUDY OF SUNSPOT NUMBER AND SOLAR RADIO FLUX BETWEEN 600 AND 9400 MHz. Rao, D. R. K. (Colaba and Alibag Observatories, Bombay). Proc. Indian Acad. Sci., Sect. A; 73: No. 5, 223-31(May 1971).

The relationship between the solar activity, as represented by sunspot number and the slowly varying component of solar radio emission at frequencies from 600 to 9400 MHz, was studied for high solar activity (1857–58), declining phase of moderate solar activity (1961–62), and ascending phase of moderate solar activity (1965–66). Regression and auto-spectrum analyses show that the association of the slowly varying radio emissions with sunspot activity is best around 3750 MHz for the high-solar-activity period, around 2800 MHz for moderate activity during the declining phase, and in between 2800 and 3750 MHz for the ascending phase of activity. The coherence between radio flux at frequencies from 600 to 9400 MHz was high and free from large fluctuations up to wavelengths as short as 7 days in the years 1961–62. At 9400 MHz, however, it was high and steady for wavelengths in excess of about 15 days. At the solar synodic rotation period, the phase difference between the sunspot number and the slowly varying component shows little change with the wavelength of the radio emission. (auth)

58615 SHOCK-FREE DECELERATION OF THE SOLAR WIND? Wallis, Max (Royal Inst. of Tech., Stockholm). Nature (London); Phys. Sci.; 233: No. 37, 23-5(3 Sep 1971).

It is stated that ionizing interactions can cause shock-free transonic deceleration both according to the hydrodynamic description of the solar-wind interaction with interstellar hydrogen and because of the presence of suprathermal ions ahead of comets and nonmagnetic planets. (auth) (UK)

58616 CURRENT SHEET MAGNETIC MODEL FOR THE SOLAR CORONA. Schatten, Kenneth H. (Goddard Space Flight Center, Greenbelt, Md.). Cosmic Electrodyn.; 2: No. 2, 232-45(Jul 1971).

A new magnetic model is developed and compared with previous models and the observed solar corona. An attempt is made to more accurately compute the three-dimensional currents flowing in the solar corona. Physical reasons are given that require most of the large-scale currents flowing in the solar corona to lie near thin sheets. The current sheets are not constrained into any particular geometry or symmetry as in the previous models of Altschuler and Newkirk (1969) and Schatten et al. (1969). A comparison with the axisymmetric, isothermal MHD solution of Pneuman and Kopp (1970) suggests that the model is able to simulate to high accuracy an isothermal corona. A comparison of the model with the May 30, 1965, solar eclipse and the November 12, 1966, solar eclipse shows the model is capable of computing many features, including the polar plume orientations as well as radial and nonradial streamers in the solar corona. (auth)

58617 ROCKET OBSERVATIONS OF THE ULTRAVIOLET SOLAR SPECTRUM DURING THE TOTAL ECLIPSE OF MARCH 7, 1970. Gabriel, A. H. (Culham Lab., Abingdon, Eng.); Garton, W. R. S.; Goldberg, L.; (and others). Astrophys. J.; 169: No. 3, 595-614(1 Nov 1971).

A sequence of thirty-five ultraviolet photographic spectra of the Sun was obtained in the wavelength region 850 to 2190 Å, as a function of time during the eclipse. These covered the range from before second contact until midtotality, with a spatial resolution of the order 2 arc sec. A general description of the experiment and data is given. Twenty-five new coronal lines were seen, the majority of which were identified as new forbidden transitions. The $L\alpha$ corona is observed out to over 1.5 $R_{\odot}$, and a quantitative interpretation is presented. Analyses of other features—e.g., prominences, quiet-atmosphere structure, and coronal condensations—are continuing. (auth)

58618 DETERMINATION OF CORONAL POLARIZATION. Menzel, Donald H. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). pp 245-50 of Topics in Modern Physics. /Brittin, Wesley E. (ed.). Boulder, Colo.; Colorado Associated Univ. Press (1971).

The problem, both theoretical and observational, of determining the distribution of brightness and polarization within the solar corona is considered. It is shown that theoretical considerations dictate that the measures of polarization must be taken in a very special manner to achieve results of highest accuracy. The basic theory is applicable generally to any problem involving studies of polarization. The observations consist of measures of apparent surface brightness of the corona as viewed through a Polaroid filter or other polarizer, with its axis set at different angles of orientation. The axis of the Polaroid is the direction of the electric vector of incident plane polarized light, for minimum transmission. (W.D.M.)

58619 SOLAR SPICULES AND CHROMOSPHERIC HEATING. Thomas, Richard N. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). pp 331-9 of Topics in Modern Physics. /Brittin, Wesley E. (ed.). Boulder, Colo.; Colorado Associated Univ. Press (1971).

A problem is described that involves both spectroscopic diagnostics and astrophysical aerodynamics from an atomic viewpoint. Chromospheric heating due to velocity fields associated with spicules is considered. (W.D.M.)

58620 MAPPING OF SOLAR POLARIZATION AT 7.8 GHz. Richards, D. W.; Straka, R. M. (Air Force Cambridge Research Labs., Bedford, Mass.). Nature (London) Phys. Sci.; 233: No. 40, 92-4(4 Oct 1971).

Two-dimensional maps of circularly polarized emission from the Sun at 7.8 GHz, with a resolution of 4.4 arc minutes, show polarization of local sources of up to 15% and variations as small as 2% in flux density and 0.2% in polarization, as functions of time. Both flux density and polarization in McMath plage 11002 showed substantial increases thirty minutes or more before a flare on October 24, 1970. It is suggested that flares may be triggered when both of these quantities surpass critical values. (auth) (UK)

58621 HELIUM-LIKE LINE-EMISSION CORONAL FEATURES. Acton, L. W. (Ireheed Pato Alto Research Lab., Calif.); Catura, R. C.; Meyerott, A. J.; Culhane, J. L. Nature (London) Phys. Sci.; 233: No. 39, 75-7(27 Sep 1971).

It is stated that since Gabriel and Jordan (Mon. Not. Roy. Astron. Soc., 145: 241(1969)) proposed a theory relating the relative intensity of the inter-system ($^3P-{}^1S_0$) and forbidden ($^3S_1-{}^1S_0$) lines of He-like ions to the electron density of the emitting volume, there has been increasing interest in using this type of information to determine electron densities in the solar corona. The present communication gives results of a rocket experiment designed to study the O VII and Ne IX helium-like ion line emission from discrete coronal features. These results indicate that electron densities in normal, nonflare, coronal features are below the low-density limits given by other workers for these ions. The instrumentation employed utilized two collimated Bragg crystal spectrometers covering the He-like "triplets" of O VII and Ne IX at 22 and 13.5 Å, respectively. It is concluded that the electron density in all observed coronal regions was less than $6 \times 10^9/cm^3$. Temperature estimates, obtained from the O VII/Ne IX resonance line ratios, indicate a variation between approximately 1.8×10^6 K and 2.9×10^6 K for the quiet corona and for the most intense x-ray features observed, respectively. (UK)

58622 EDDY VISCOSITY AND THE SOLAR ROTATION. Starr, V. P. (Massachusetts Inst. of Tech., Cambridge). Nature (London); 233: No. 5316, 186-7(17 Sep 1971).

It has been suggested that the deep interior of the Sun rotates faster than the visible exterior. One result would be that the departure of the mass distribution from spherical symmetry could, through its quadrupole moment, cause a contribution to the advance of the perihelion of Mercury, on the basis of Newtonian mechanics. Unless the fast interior rotation and the corresponding interior mass distribution are known, and correct allowances made, no precise check of the general relativity theory can be made on the basis of the astronomically observed perihelion advance. The question is considered as to whether some such situation concerning interior rotation can be established, or at least plausible. It has been stated that, apart from plausible magnetic complications, an equatorial acceleration in planetary and other atmospheres cannot be maintained by axisymmetric systems of motion, but requires what amounts to a negative eddy viscosity due to nonzonal disturbances in the motion and pressure. In this connection an analogy is drawn with the Earth's atmosphere. The phenomenon is sometimes called pseudo-viscosity. The whole process requires energy sources within the structure of the eddies. It is also thought possible that many stellar interiors may have a fast rotation sustained by a vertical inward angular momentum transport due to eddies. It is suggested that theoretical and numerical mathematical models be constructed that would allow for these possibilities. (UK)

Galaxies

58623 SOME COOLING PROCESSES FOR THE INTERSTELLAR MEDIUM. Voronin, A. I.; Gordeev, E; P.; Umanskii, S. Ya. (Inst. of Chemical Physics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 214-17(Sep-Oct 1971).

Translated from Astron. Zh.; 48: No. 2, 275-9(Mar-Apr 1971).

A calculation was made for the cross sections of transitions between the fine-structure components of C and O atoms colliding with H atoms. These transitions may play a major role in the process of cooling the interstellar medium. Exchange, dispersion, and spin-orbital interactions were taken into account in the calculation. The computed cross sections were $\approx 10^{-15}$ cm^2 for C atoms and 10^{-16} cm^2 for 0 atoms in the 100 to 1000°K temperature range. (auth)

58624 STRUCTURE OF THE RADIO SOURCE SAGITTARIUS A. Lipovka, N. M. (Central Astronomical Observatory, Pulkovo, USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 203-9(Sep-Oct 1971).

Translated from Astron. Zh.; 48: No. 2, 260-8(Mar-Apr 1971).

Observations are reported of the Sgr A region with the large Pulkovo radio telescope at $\lambda = 4$ cm (resolution $\varphi_A = 1.5 \times 90'$). Measurements in the centimeter range agree well with a thermal model for the nucleus measuring 4.5 × 10 pc. The infrared measurements at $\lambda = 1.65$ to 3.4 μ from a region 110″ across tend to support rather than disprove this model. At decimeter wavelengths (λ= 21 to 350 cm) nonthermal radiation from a region measuring 8 × 16 pc predominates. Observations in the excited-hydrogen lines, observations of OH and CH_2O in absorption, the presence of a large amount of dust, and the possibility that compact H II regions (such as feature No. 1) may occur in the nucleus all represent evidence that conditions suitable for star formation may prevail in the galactic nucleus. (auth)

58625 HOW TO FIND YOUNG GALAXIES. Sargent, W. L. W.; Searle, L. (California Inst. of Tech., Pasadena). Comments Astrophys. Space Phys.; 3: No. 4, 111-14(Jul-Aug 1971).

The criteria that might be used to identify young galaxies, supposing they exist, are discussed. By young galaxies is meant objects in our neighborhood of the Universe (within a few hundred Mpc) that have ages appreciably less than the Hubble time ($\sim 10^{10}$ years). (W.D.M.)

58626 ARE QUASI-STELLAR OBJECTS THE NUCLEI OF EMBRYONIC GALAXIES? Komberg, B. V.; Syunyaev, R. A. (Inst. of Applied Mathematics, Moscow Academy of Sciences of the USSR). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 183-6(Sep–Oct 1971).

Translated from Astron. Zh.; 48: No. 2, 235-9(Mar–Apr 1971).

If quasi-stellar objects represent an early active evolutionary phase in the nuclei of certain types of galaxy, they might be surrounded by massive ($M \approx 10^{11}$ $M_\odot$), extended ($r \approx 30$ to 100 kpc) regions of gas, or protogalaxies, which are subsequently to disintegrate into stars. These gaseous regions, ionized by the intense ultraviolet radiation of the central source (the quasi-stellar object), might be detected from their strong radiation in narrow hydrogen recombination lines. Detailed spectroscopic or colorimetric investigations of the nebula around the quasar 3C 48 might provide an observational test of the proposed model. (auth)

58627 INSTABILITY OF WEAK IONIZATION WAVES OF D TYPE. Krasnobaev, K. V. (Inst. of Cosmic Research, Moscow). Dokl. Akad. Nauk SSSR; 196: No. 6, 1291-3(21 Feb 1971). (In Russian).

Under cosmic conditions a movement of interstellar gas often occurs that is characterized by a sharp transition from almost completely ionized hydrogen to a neutral atomic state. One may regard this transition region as the surface of a discontinuity with gas-dynamic parameters (velocity, density, temperature, degree of ionization, etc.). Mathematical relationships were developed involving the ionized front, the velocity, and other parameters, and limits were found within which must lie the ionized discontinuity of instability for a wide range of Mach numbers. (K.S.W.)

58628 ARE THE GALACTIC LOOPS SUPERNOVA REMNANTS? Berkhuijsen, Elly M.; Haslam, C. G. T.; Salter, C. J. (Leiden Observatory, NRAL, Jodrell Bank, Eng.). Astron. Astrophys.; 14: No. 2, 252-62(Sep 1971).

Observational evidence is presented on the nature of the Galactic continuum loops. Their small circle geometry is discussed. A relationship between neutral hydrogen features at intermediate and high latitudes and the continuum loops was found. A link between Loop I and the runaway star ζ Ophiucus is suggested. The available evidence would seem to favor the supernova-remnant hypothesis for the origin of the Galactic loops. (auth)

58629 OPTICAL LINE SPECTRUM OF A GAS HEATED BY HARD UV RADIATION OR ENERGETIC PARTICLES. Bergeron, J. (Cornell Univ., New York); Souffrin, S. Astron. Astrophys.; 14: No. 2, 167-88(Sep 1971).

The line emission spectrum of moderately ionized regions was calculated for cases of homogeneous heating. The heating sources considered were either hard-uv radiation (energy of order of 10^2 eV) or energetic particles (MeV protons). The physical conditions in the diffuse gas were calculated for various primary ionization rates per total hydrogen number. The ionization equilibria of hydrogen, helium, nitrogen, oxygen, and neon were determined and forbidden line as well as hydrogen and helium line emissivities were computed. The general characteristics of both heating mechanisms are given and the range of application of homogeneous heating is discussed. Observations of line intensities of nuclei of galaxies were compared with the models, and fair agreement was found for radiation heating. Furthermore, the theoretical total power radiated in the nucleus of Seyfert galaxies, mainly in the form of 200-eV photons, was computed. Good agreement with recent soft x-ray observations was found. (auth)

58630 He^+/H^+ CONCENTRATION RATIOS IN H I REGIONS. Jura, M.; Dalgarno, A. (Harvard Coll. Observatory, Cambridge, Mass. Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astron. Astrophys.; 14: No. 2, 243-5(Sep 1971).

The observation of helium recombination lines in the hot intercloud medium may allow a choice between the cosmic-ray and soft-x-ray steady-state models of the interstellar medium. For an abundance ratio of helium to hydrogen of 0.1, the cosmic-ray model leads to an He^+/H^+ concentration ratio not more than 0.09 and the soft x-ray model to concentration ratios ranging from 0.15 to 0.34 for regions with fractional ionizations greater than 10^{-3}. For regions with fractional ionizations less than 10^{-3}, a radiative charge-transfer process causes very low equilibrium abundances of He^+ ions and helium recombination lines will be weak in interstellar clouds. (auth)

58631 INTERSTELLAR MATTER AND THE LOCATION OF THE SHOCK FRONT. Fahr, H. J. (Univ., Bonn). Planet. Space Sci.; 19: No. 9, 1121-9(Sep 1971).

The initially supersonic flow of the solar wind passes through a magnetic shock front where its velocity is supposed to be reduced to subsonic values. The location of this shock front is primarily determined by the energy density of the external interstellar magnetic field and the momentum density of the solar-wind plasma. Interstellar hydrogen penetrating into the heliosphere undergoes charge exchange processes with the solar-wind protons and ionization processes by the solar euv radiation. This results in an extraction of momentum from the solar-wind plasma. Changes of the geometry and the location of the shock front due to this interaction are studied in detail and it is shown that the distance of the magnetic shock front from the Sun decreases from 200 to 80 AU for an increase of the interstellar hydrogen density from 0.1 to 1.0-cm^{-3}. The geometry of the shock front is essentially spherical with a pronounced embayment in the direction opposite to the approach of interstellar matter which depends very much on the temperature of the interstellar gas. Due to the energy loss by the interaction with neutral matter the solar-wind plasma reduces its velocity with increasing distance from the Sun. This modifies Parker's solution of a constant solar-wind velocity. (auth)

58632 HYDROGEN LINE AND CONTINUUM STUDY OF MAFFEI 2 BY RADIO INTERFEROMETRY. Shostak, G. S.; Weliachew, L. (California Inst. of Tech., Pasadena). Astrophys. J.; 169: No. 2, L71-6(15 Oct 1971).

The suspected spiral galaxy Maffei 2 was interferometrically observed in the 21-cm line and adjacent continuum using a north–south baseline having a 6.5′ fringe spacing. Velocity resolution was 21 km s^{-1}. Positions of the emission centroids at each velocity allowed determination of the orientation and dynamic parameters of the object and a lower limit to the total mass. The fractional hydrogen content of Maffei 2 is less than 0.005 D, where D is the distance in Mpc. The continuum source associated with it is shown to be extended. (auth)

58633 SPECTROPHOTOMETRIC STUDY OF THE NGC 3627 GALAXY NUCLEUS FROM 3,300 TO 7,000A. Alloin, D. (Centre National de la Recherche Scientifique, Paris). Compt. Rend., Ser. B; 273: No. 1, 53-6(5 Jul 1971). (In French).

New photometric and spectroscopic results relating to the NGC 3627 galaxy nucleus are given. (France)

58634 THEORY OF THE SPIRAL STRUCTURE OF THE GALAXY. Petit, J. P. (Marseille Univ.). Compt. Rend., Ser. B; 272: No. 24, 1389-92(14 Jun 1971). (In French).

The method of perturbation is used to analyze the gravitational stability of a conglomeration of interstellar gas whose differential rotation arises from coupling with the gas of stars. Collective and local uncoupled effects are assumed, the collisions ensuring

XUM

the Maxwellian nature and isothermal conditions, the collective processes being responsible for the perturbation. The medium appears to be sensitive to a Jeans' type instability. A wave equation leading to spiral structures coherent with observation is derived. (France)

58635 MEAN RATIO OF MASS TO THE THREE-HALVES POWER OF LUMINOSITY FOR ELLIPTICAL AND LENTICULAR GALAXIES. Noonan, Thomas W. (Brockport State Coll., N. Y.). Publ. Astron. Soc. Pac.; 83: No. 494, 479-84(Aug 1971).

The available data on masses of ellipticals and lenticulars are summarized with emphasis on the uncertainties in the ratio R of mass to $10^{-0.6M}$, where M is the absolute magnitude. With correction for galactic absorption, the result is $R = 0.30^{+0.27}_{-0.14}\ \mathfrak{M}_\odot$ (and, as a by-product, a mean mass–luminosity ratio of 38^{+27}_{-16}) based on the magnitude scale in the de Vaucouleurs' catalog. The mass–luminosity relations by Poveda, Rood, and Vorontsov-Velyaminov give values of R in the same range. Implications for the mean cosmic density are discussed. (auth)

58636 STELLAR POPULATIONS IN GALAXIES. King, Ivan R. (Univ. of California, Berkeley). Publ. Astron. Soc. Pac.; 83: No. 494, 377-400(Aug 1971).

Present-day knowledge of stellar populations and the relation of populations to the forms of galaxies is reviewed. A historical outline of the concept of populations is followed by a summary of the present picture. After a discussion of the distribution of populations in the various types of galaxies, it is shown that the whole picture can be understood in terms of a simple scheme of the development of galaxies. Problems of heavy-element enrichment through nucleosynthesis are briefly discussed. The article aims at being provocative rather than definitive but retains a basically conservative point of view. (auth)

58637 MODEL OF INTERSTELLAR GRAINS WITH SURFACE ROUGHNESS. Shah, G. A.; Vardya, M. S. (Tata Inst. of Fundamental Research, Bombay). Astrophys. Space Sci.; 12: No. 1, 250-5(Jul 1971).

A simple model of surface roughness on the interstellar spherical grains was considered. A test case with dirty ice spherical grains revealed that the effect of surface roughness is to significantly enhance the extinction in the far ultraviolet compared to the equivalent smooth spheres. (auth)

58638 DIFFUSE RADIATION OF THE GALAXY IN FAR UV ACCORDING TO THE INVESTIGATIONS BY S. HAYAKAWA, K. YAMASHITA, AND S. YOSHIOKA. Rozkovskii, D. A.; Makyagin, V. S. (Astrophysical Inst., Alma-Ata, USSR). Astrophys. Space Sci.; 12: No. 1, 204-7(Jul 1971).

It has been found that certain optical properties of interstellar grains obtained by Hayakawa et al. (1969) from their study of the diffuse radiation of the Galaxy in far-uv are not in reality consistent with the more-accurate theoretical calculations of diffuse radiation for the model of the Galaxy used by Hayakawa et al. in their work. A more complex model of the Galaxy may be required for interpretation of observations in far-uv. (auth)

58639 MAP OF THE GALACTIC NUCLEUS AT 10 μm. Rieke, G. H.; Low, F. J. (Univ. of Arizona, Tucson). Nature (London); 233: No. 5314, 53-4(3 Sep 1971).

The centre of the Galaxy was scanned on Feb 15, 1971 at 10 μm using the NASA 61-inch telescope at the Catalina Observatory, with a beam of diameter 5.5 arc sec, and the scans were combined to form the map shown. Four sources could be distinguished, together with an additional broad emission zone. Some observations were also made at 2.2, 5, and 22 μm. The total flux from the galactic centre was estimated as $480 \pm 50 \times 10^{-26}$ W/m^2 Hz at 10 μM, and that at 22 μm as $2{,}300 \pm 250 \times 10^{-26}$. Some ambiguities are discussed. (UK)

58640 SIMILARITY MODELS OF INTERSTELLAR LOOP STRUCTURES. Zuzak, W. W. (Univ. of Manchester, Eng.). Astron. Astrophys.; 15: No. 1, 95-109(Nov 1971).

It is hypothesized that the interstellar loop structures are continuously driven by means of cosmic rays emitted by some source near the center. Spherical similarity solutions, in which the shock position varies with time according to $R = At^\alpha$, are obtained in the approximation that all fluid motion is radial, $u = (u_r, 0, 0)$, the magnetic field is tangential, $B = (0, 0, B_\varphi)$, and the diffusion coefficient η is zero. Any desired shell thicknesses may be obtained by considering the radiation losses to occur at the shock and thereafter treating the shocked gas adiabatically. The total energy of the shell and the rate of energy input are given by $\epsilon \sim t^{5\alpha-3}$ and $\partial\epsilon/\partial t \sim t^{5\alpha-3}$, respectively. The solutions show that the magnetic field near the contact surface at the inside of the shell is sharply peaked to a maximum value which is approximately independent of the value of the initial magnetic field. Sharp steps in the radio synchrotron emission are to be expected in scanning across such regions. Information available on Loops I and II (North Polar Spur and Cetus Arc) indicate that these have undergone relatively large cooling and are driven by a relatively small energy input. (auth)

58641 DENSITY COMPUTATION FOR THE GALACTIC MODEL OF L. PEREK. Rodionov, V. I. (Leningrad State Univ). Bull. Astron. Inst. Czech.; 22: No. 4, 162-8(1971).

The phase-space model of the Galaxy proposed by L. Perek (1966) was examined. The behavior of the density function outside the plane of symmetry of the model was studied. (auth)

58642 OBSERVATIONS OF CORE SOURCES IN SEYFERT AND NORMAL GALAXIES WITH THE WESTERBORK SYNTHESIS RADIO TELESCOPE AT 1415 MHz. van der Kruit, P. C. (Sterrewacht, Leiden). Astron. Astrophys.; 15: No. 1, 110-22(Nov 1971).

Eight Seyfert and ten normal galaxies were observed with the Westerbork Synthesis Radio Telescope at a frequency of 1415 MHz. Unresolved sources (<7″) were detected in the nuclei of all galaxies previously classified as Seyferts. Of these NGC 3077 was much weaker than the others, which is compatible with the absence of broad emission lines and NGC 4670, for which the Seyfert classification was tentative, has a nuclear source comparable to the well-established Seyferts. For two Seyfert galaxies upper limits of 5% were put on the degree of linear polarization. No radiation was detected from Markarian 205 (Weedman, 1970). In only three of the ten "normal" galaxies radio emission was detected: NGC 3310 (point-source in the nucleus), NGC 3726 (two sources symmetrically placed with respect to the nucleus), and NGC 4736 (triple source, with the middle one in the nucleus). The structure showed no evidence for relativistic effects (Ryle and Longair, 1967). The observations showed that complex structures observed in radio galaxies exist also within normal galaxies. The 1415-MHz power of the other 11th to 12th magnitude galaxies was shown to be less than about 10^{19} W Hz^{-1} sterad^{-1}. The analysis showed that there is a relation between the 1415-MHz and 10-μ power for the nuclei of Seyfert galaxies. Similar relations may exist between the powers at 1415 MHz and those in the optical continuum and H_β. This is briefly discussed in terms of the recent model given by Cavaliere et al. (1970), where the electrons radiating at radio wavelengths originate from the small core, where the infrared radiation is emitted. (auth)

58643 SMALL CLUSTERS OF GALAXIES AND THE MASS TO-LIGHT RATIO. Taff, L. G.; DeAngelis, Umberto (Univ. of Rochester, N. Y.). Astron. Astrophys.; 15: No. 1, 1-10 (Nov 1971).

The stability of 19 clusters of galaxies was investigated in an attempt to combine the virial theorem with the current mass-to-light ratios to obtain the mass distribution function for galaxies. There were 11 triplets, 4 quartets, and 4 quintets in the sample. A gross classification into Hubble classes of elliptical, spiral, and irregular showed the sample did not differ markedly from the general field. A detailed numerical analysis of possible masses for the galaxies lead to three conclusions: (1) most of these systems are probably not stable, (2) in those considered to be gravitationally bound the usual problem of high mass-to-light ratios is not encountered, and (3) current mass-to-light ratios are not statistically significant. Due to the first and third conclusions the mass distribution function could not be defined. (auth)

58644 DETERMINATION OF THE LUMINOSITY FUNCTION OF RADIO GALAXIES AT 400 AND 2700 MHz. Merkelijn, Jeannette K. (Sterrewacht, Leiden). Astron. Astrophys.; 15: No. 1, 11-29(Nov 1971).

The results of a statistical treatment of the radio galaxy identifications from the Parkes catalogue are presented. Identification statistics are also given for quasi-stellar objects. A special effort was made to minimize the errors in apparent optical magnitude and flux density. The effects of galactic absorption, limiting apparent optical magnitude, and limiting flux densities on the completeness of the samples were investigated. The resulting complete samples were used in the construction of luminosity distributions and a luminosity function at frequencies of 400 and 2700 MHz. Over the range $\log P_{400} = 23$ to 26 covered by the present investigation the luminosity function can be represented by the equation: $\log(N(\log P_{400})) = -1.06 \log P_{400} + 19.96$ where N is the number of radio galaxies per cubic megaparsec per unit interval of 0.4 in $\log P_{400}$ and P_{400} is the monochromatic power at an emission frequency of 400 MHz in WHz^{-1} sterad^{-1}. Luminosity functions were also constructed for the nearer and farther half of the observable volume. From this it was found that for $\log P_{400} > 24.4$ the density in the farther half, at $\langle z \rangle = 0.17$ was a factor two higher than in the nearer half, at $\langle z \rangle = 0.10$. This is ascribed to evolution. It is concluded that to explain the result it is necessary that at least the radio galaxy population with $\log P_{400} > 24.4$ evolves with epoch. That the low-luminosity population evolves too is unlikely in view of the 2700 MHz results. The luminosity function was found to be frequency independent for the frequencies investigated. The agreement with the results of previous investigations was satisfactory. (auth)

58645 RADIO CONTINUUM OF GALAXIES. I. OBSERVATIONS. Lequeux, J. (California Inst. of Tech., Pasadena. Observatory, Meudon, France). Astron. Astrophys.; 15: No. 1, 30-41(Nov 1971).

Positions, flux densities in the continuum near 1420 MHz, and east–west brightness distributions were measured for 54 spiral and irregular galaxies and 20 radio-weak elliptical galaxies. Upper limits for the flux density are given for 16 spiral and irregular galaxies and 7 elliptical galaxies. The observations were made with the two-element interferometer at the Owens Valley Radio Observatory. It was confirmed that the radio emission of spiral and irregular galaxies comes from a flat radio disk and/or a radio nucleus, the properties of which are discussed. NGC 5253 is an exceptional object with purely thermal radio emission. Elliptical galaxies fall into two distinct categories from their radio properties: in a given volume of space, about half of the galaxies the most powerful at high frequencies are extended and have a steep radio spectrum; the other half have a small radio diameter and a flat or complex spectrum. The latter show emission lines in their optical spectrum. (auth)

58646 RADIO CONTINUUM OF GALAXIES. II. ORIGIN OF CONTINUUM EMISSION IN SPIRAL GALAXIES. Lequeux, J. (California Inst. of Tech., Pasadena. Observatory, Meudon, France). Astron. Astrophys.; 15: No. 1, 42-9(Nov 1971).

The distribution of young population I and the distribution and rate of appearance of supernovae in the Galaxy and external spiral galaxies are compared with the diameter and distribution of the disk continuum radio in these galaxies. Marked correlations are found, and it is suggested that the relativistic electrons which produce the disk radio emission are accelerated in supernovae and propagate by diffusion in the galaxy, leaving it at about 500 pc from their source, in agreement with the model of Jokipii and Parker (1969). Radio emission in the nuclei of spiral galaxies may also be due to electrons ejected by supernovae, at least for a fraction of them. (auth)

58647 INTERSTELLAR GRAIN ALIGNMENT BY A MAGNETIC FIELD. Martin, P. G. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 153: No. 3, 279-85(1971).

The role of the galactic magnetic field in the alignment of interstellar grains believed to cause optical polarization is discussed. The angular momentum of a charged grain is shown to precess about the magnetic field on a timescale less than the relaxation time of most alignment mechanisms, thus introducing the magnetic field as an important factor in many processes other than the Davis–Greenstein mechanism. The different predictions of Davis–Greenstein alignment and alignment combined with precession are presented. Recent direct observational evidence concerning magnetic alignment raises both positive support and contradictions. (auth)

58648 COMPACT GALAXIES. Fairall, A. P. (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc.; 153: No. 3, 383-92(1971).

An observational investigation was carried out on compact galaxies identified on the Palomar Sky Survey. Their colors and spatial distributions are discussed. Results of image tube spectroscopy, made at McDonald Observatory, of 44 compact galaxies are reported. They indicate that the majority, those redder in color, have conventional stellar spectra, while the bluer objects are of a more diverse nature. Spectra of three red compacts (obtained by Zwicky with the Palomar 200-inch telescope) are compared with spectra of conventional galaxies, and it is suggested that the high surface brightness of these compact galaxies may be accounted for by a greater proportion of high-luminosity stars. (auth) (UK)

58649 OUTWARD DRIFT OF THE INTERSTELLAR MEDIUM IN THE DISK OF THE GALAXY. Harrison, Edward R. (Univ. of Massachusetts, Amherst). Mon. Notic. Roy. Astron. Soc.; 153: No. 3, 12P-16P(1971).

It is proposed that the gaseous component in the disk of the Galaxy has an outward radial drift velocity relative to the stellar component. The drift is the result of nongravitational forces (in particular, the radial pressure gradient) acting on the gas, and the dynamic coupling (mainly due to mass exchange) between gas and stars. The gas flow has trailing spiral streamlines relative to the stars. It is estimated that at the Sun's distance from the galactic center the radial velocity is 0.5 km s^{-1}, and the tilt of the spiral streamlines is 10°. Some comments are made on the possible importance of the motion concerning the origin of spiral structure. (auth) (UK)

58650 SPECTRUM AND GALACTIC ISOTROPY OF DIFFUSE COSMIC X RAYS. Davison, P. J. N.; Thomas, R. M. (Univ. of Adelaide). Nature (London) Phys. Sci.; 233: No. 37, 27-9(13 Sep 1971).

Measurements are reported of the spectrum of the diffuse cosmic x-ray background, together with estimates of the isotropy of the background with respect to galactic latitude, and an upper limit for a line source of x rays along the galactic equator, using a balloon-borne detector launched from Mildura, Australia on Feb. 29, 1968. Background x rays as measured by balloon-borne x-ray telescopes are a mixture of those of atmospheric origin, of spurious counts due to imperfect shielding of the detector, and of genuine cosmic x rays, and the method of obtaining the latter is described and the spectrum obtained is shown. A galactic latitude survey was carried out and the data analyzed for the energy range 26 to 67 keV, excluding regions of the sky containing resolved discrete sources. The anisotropy factor obtained was $\alpha = 17.5 \pm 9.5\%$. The observations were interpreted in terms of an upper limit for α and are not regarded as the result of a diffuse flux. The results may be presented in terms of a derived line flux in the galactic plane rather than in terms of α, and values for this are shown graphically. (UK)

58651 ABSORPTION-LINE STUDY OF THE GALACTIC NEUTRAL HYDROGEN AT 21 CENTIMETERS WAVELENGTH. Hughes, M. P.; Thompson, A. R.; Colvin, R. S. (Stanford Univ., Calif.). Astrophys. J., Suppl. Ser.; 23: No. 200, 323-67(Oct 1971).

The interferometer at the Owens Valley Radio Observatory, together with a multichannel receiving system with filters of bandwidth 4 or 6 kHz, was used to observe ninety-seven sources for absorption at 21-cm wavelength. All but four of the sources were believed to be extragalactic. Measurable absorption was detected in sixty-four cases, and for these the profiles are presented. Optical depths greater than 0.5 were found only within 20° of the galactic plane, except in the region of the Cetus Arc where values up to 1.4 occur near $b = -40°$. The highest galactic latitude at which absorption was detected was 75° for Vir A. Upper limits for the optical depths of two intermediate-velocity clouds near $b = 40°$ were 0.02 and 0.06. The mean temperature of the cool absorbing gas was found to be 71 ± 9°K, and this figure was corrected for the effects of the surrounding hot gas. The highest lower limit for the temperature of the hotter gas was ~600°K. There was also some evidence of temperatures of a few hundred degrees Kelvin. On the assumption that the interstellar gas has a two-temperature structure, an analysis was made to determine the fraction of the neutral atomic hydrogen in the cool state. For a line of sight close to the galactic plane, a figure of about 75% was obtained. For the general vicinity of the Sun, the result was 36 to 45%, depending upon the temperature ratio of the two states of the gas, and this was probably also a good estimate for the whole galaxy. A comparison of 21-cm absorption with published measurements of the free–free absorption for three of the sources resulted in a mean value for the ionization rate of 2.0×10^{-15} s^{-1}. This figure referred to gas in the cool state and within 2 kpc of the Sun. The distance of the excess absorbing gas in the direction of Cetus Arc was found to be ≤120 pc from a comparison of velocities of 21-cm absorption features with those of absorption lines in nearby stars. For the galactic source 3C 58, a lower limit of 8.5 kpc was obtained for the distance. (auth)

58652 NEUTRAL HYDROGEN IN AN INTERIOR REGION OF THE GALAXY. THE LONGITUDE INTERVAL 22^0 TO 42^0. I. OBSERVATIONS. Shane, W. W. (Leiden Observatory). Astron. Astrophys., Suppl. Ser.; 4: No. 1, 1-42(Aug 1971).

Measurements of the 21-cm hydrogen emission near the galactic plane were made using the 25-m telescope in Dwingeloo. The region $l = 22.3$ to 42.3° was surveyed at 1° intervals in longitude, with an extent to between 6 and 9° on either side of the galactic equator. The observing and reduction procedures are described briefly. The observations consist in line profiles and

XUM

latitude scans. The reduced measurements are reproduced graphically. (auth)

58653 NEAR-ULTRAVIOLET SURFACE PHOTOMETRY OF THE SOUTHERN MILKY WAY. Pfleiderer, J. (Univ., Bonn); Mayer, Ursula. Astron. J.; 76: No. 8, 691-700(Oct 1971).

Isophote maps are presented of the Milky Way (except the northern region from Per to Cep/Cyg): color — U of the UBV system; field of view — ~1 deg^2; resolution — 1 to 2°. The mean intensity of the inner Milky Way is about 100 S_{10}(U) [intensity at poles 15 to 20 S_{10}(U)]. The brightest areas, with intensities up to several hundreds S_{10}(U), are in Sgr/Sco, Car, Vel/Pup, and Cyg. Most bright areas coincide with OB associations and extended Hα regions, and many other such objects are clearly visible, probably due to Balmer continuum emission. The reduction procedure is described in detail. (auth)

58654 PHOTOMETRIC MEASUREMENTS AT $\lambda = 11$ μm OF NGC 4151. Stein, W. A.; Gillett, F. C. (Univ. of California, San Diego). Nature (London) Phys. Sci.; 233: No. 36, 16-18(6 Sep 1971).

The results presented arise from data accumulated over the period June 1969 to June 1971 with a view to investigating the possible variability of NGC 4151 in regard to infrared radiation. It appeared that variations on short time scales ($\leq$1 month) occurred at various times during the course of the observations, although it is recognised that such observations could be misleading on a short time scale. It is concluded that, in spite of the fact that sometimes it has appeared that changes of flux level have occurred on short time scales, if all measurements are included no flux changes can be conclusively shown to be outside of a normal statistical dispersion of results. (UK)

58655 INTERPRETATION OF THE Hα PROFILE OF THE SEYFERT GALAXY NGC 5548. Anderson, Kurt S. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 169: No. 3, 449-53(1 Nov 1971).

Spectroscopic observations of the Hα profile in the Seyfert galaxy NGC 5548 suggest that electron scattering is not the dominant factor in producing the extensive emission wings. The profile shows indications of discrete cloud structures. The predictions of a simple model based upon radial expansion about an optically thick central region are compared with the observations. (auth)

58656 COLLECTIVE INSTABILITIES AND WAVES FOR INHOMOGENEOUS STELLAR SYSTEMS. II. THE NORMAL MODES PROBLEM OF THE SELF-CONSISTENT PLANE-PARALLEL SLAB. Mark, James W.-K. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 169: No. 3, 435-75(1 Nov 1971).

Studies were made of the normal modes of instabilities and waves for models of inhomogeneous, nonrotating stellar systems whose basic equilibrium has one-dimensional planar symmetry (slabs) while the perturbations are not restricted to this symmetry. Comparisons were also made with gaseous slabs, the energy principle, and the Hartree–Fock operator principle. The perturbations separate into modes even and odd in the spatial coordinate parallel to the density gradient. For even modes, the gravitational instability was isolated under more general conditions than in a previous derivation that used the energy principle. A two-stream instability was identified at long wavelengths as an even mode. Bending-type odd modes were also found. For nearly isotropic velocity distributions, this bending mode is a propagating, neutral (or slightly damped) wave, while for large velocity anisotropies, the Kelvin–Helmholtz (fire-hose) instability is recovered. For initial-valued problems involving this inhomogeneous equilibrium, each of these modes gives a pole singularity in the Laplace transform of the time behavior. (auth)

58657 DYNAMIC EQUATION FOR STOCHASTIC MAGNETIC FIELD LINES IN THE GALAXY. Jones, Frank C. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 169: No. 3, 477-85(1 Nov 1971).

It has been pointed out by previous authors that the turbulent motion of the ionized interstellar gas will cause a given line of force of the galactic magnetic field to wander in a random manner even though the average field may be quite regular. An equation is derived that describes the development of the probability density of a given field line as a function of distance along the average field. It is explained why a Fokker–Planck type of equation is quite unsuitable in this case and it is shown that the answer must be sought in the theory of stationary Gaussian processes. The distribution function for the "endpoints" of a field line that starts on the galactic central plane is also derived. Endpoint in this context means the point where the field line first wanders so near the surface of the galactic disk that it can no longer confine cosmic rays. (auth)

58658 SPECTRUM OF AP LIB (PKS 1514-24). Rodgers, A. W. (Australian National Univ., Canberra). Nature (London) Phys. Sci.; 233: No. 39, 75(27 Sep 1971).

The rapid and erratically variable AP Lib was identified with the radio source PKS 1514-24. It appears to have no emission lines between 6500 and 4300 Å, and has been classified as an N galaxy. The similarity between AP Lib and BL Lac is discussed, and spectra of AP Lib are described, obtained in August 1971 with the 74-inch telescope at Mount Stromlo Observatory. The image of AP Lib was observed to be stellar when the seeing image was less than 1.5 arc s in diameter, supporting the classification of AP Lib as an N-type galaxy. It was apparent from the energy distribution in the continuous spectra that AP Lib, at the time observed, possessed a marked uv excess relative to stars of similar blue-visual gradient, in agreement with the photometry of PKS 1514-24, and indicating a marked spectrophotometric similarity between AP Lib and BL Lac. (UK)

Cosmology

58659 COUNTS OF SOURCES AND THEORIES. Brecher, K.; Burbidge, G.; Strittmatter, P. A. Comments Astrophys. Space Phys.; 3: No. 4, 99-110(Jul-Aug 1971).

If any class of extragalactic object is distributed uniformly in space, counts to successively increasing metric distance, and hence to fainter apparent brightness will give numbers proportional to the volumes. The method has been applied extensively to extragalactic radio sources. Topics considered in some detail include interpretations of the log N–log S curve for bright sources, possible interpretations of the counts of fainter sources, and isotropy of the source counts and the background radiation. (W.D.M.)

58660 LOCALIZABILITY OF PARTICLES IN DE SITTER SPACE. Hannabuss, K. C. (Mathematical Inst., Oxford). Proc. Cambridge Phil. Soc.; 70: 283-302(1971).

Motivated by the Iwasawa decomposition and its geometrical interpretation, two new decompositions of the de Sitter group are obtained. The first is applied to construct the representations of the de Sitter group in a form immediately comparable with those of the Poincaré group. In particular, they act on functions over an hyperboloid like the momentum hyperboloid of the Poincaré group, although they require both positive and negative mass shells of that hyperboloid. Using the second decomposition it is shown that the representations of the de Sitter group are localizable in the sense of Mackey and Wightman. Position operators are exhibited. (auth)

58661 COSMICAL CONSTANT. McCrea, W. H. (Univ. of Sussex, Brighton, Eng.). Quart. J. Roy. Astron. Soc.; 12: No. 2, 140-53(Jun 1971).

Ever since the beginning of relativistic cosmology the cosmical constant has in one way or another played a prominent but ill-understood part. It makes its appearance in general relativity as allegedly a universal constant, awaiting both a meaning and a value, in a theory that seemingly ought by its nature to involve no universal constants. This situation is reviewed. The tentative conclusion is reached that, if general relativity is to be treated as a self-contained theory, then the "cosmical terms" that contain the cosmical constant should be omitted. But if general relativity is treated as only a part of what is needed to construct a theoretical model of physical reality, then the cosmical terms ought to be retained as affording additional freedom in linking up with other parts of physical theory. In that case, it seems reasonable to expect that the cosmical constant may have to be assigned different values in different applications of the theory. So far as relativistic cosmology is concerned, the pragmatic treatment of the cosmical constant implicitly employed at the present time by most cosmologists seems to be entirely reasonable, although there is still no accepted cosmological value of the constant. (auth)

58662 MEASUREMENT OF THE GRAVITATIONAL DEFLECTION OF RADIO WAVES BY THE SUN. Hill, J. M. (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Mon. Notic. Roy. Astron. Soc.; 153: No. 3, 7P-11P(1971).

The deflection of radio waves in the Sun's gravitational field was measured by using the Cambridge One-Mile telescope to observe the radio source 3C 279 before and after its occultation by the Sun on October 8, 1970. The observed deflection was 1.07 ± 0.17 times that predicted by general relativity. (auth) (UK)

58663 TIME SCALE OF EXPANSION FOR COSMOLOGICAL MODELS WITH RADIATION. Edwards, D. (Univ. of Liverpool). Mon. Notic. Roy. Astron. Soc.; 153: No. 3, 17P-20P(1971).

Exact expressions are derived in terms of the basic parameters for Friedmann models containing noninteracting matter and radiation. (auth) (UK)

58664 DECISIVE TEST FOR GENERAL RELATIVITY. Blokland, A. Astrophys. Space Sci.; 12: No. 1, 219-42(Jul 1971).

A very accurate evaluation of the Schwarzschild constants is now possible from continuous observation of the spin axes of coupled gyroscopes because the angular velocities of these axes can be more than 100,000 times greater than the better-known precession velocity of a single gyro in orbit around the Earth. This enormous increase in velocity is a consequence of a gravomagnetic effect in gravitational interaction that resembles the electromagnetic effect in electrical interaction. (auth)

58665 SPIN STATE OF ATOMS AND MOLECULES IN A COSMIC MEDIUM. Varshalovich, D. A. (Ioffe Inst. of Physics and Tech., Leningrad). Usp. Fiz. Nauk; 101: 369-83(Jul 1970). (In Russian).

Nonequilibrium dynamic (in contrast to equilibrium static) orientation of particle spins must be a very widespread phenomenon in the Universe. The spins of particles align mainly as a result of oriented streams of nonpolarized radiation that proceeds from stars and nebula. The alignment of spins leads to change of transparency of the medium for resonance radiation. This phenomenon essentially has to be considered, for information purposes, for all resonance radiation passing through the cosmic medium. The calculation of alignment not only can give corrections to partial densities of particles, but permits qualitative determination of the direction of the magnetic field and anisotropy of streams of radiation in the medium. 41 references. (tr-auth)

58666 WAS THERE REALLY A BIG BANG? Burbidge, G. (Univ. of California, San Diego). Nature (London); 233: No. 5314, 36-40(3 Sep 1971).

It is stated that evidence in favor of a "big-bang" cosmology is much less definite than often realized, and it is not impossible that we are living in a steady-state Universe. After a general introduction to the subject the following are discussed: determination of the deceleration parameter, redshifts of faint sources, corrections for evolution, the Stebbins–Whitford effect, counts of radio sources, volume effect or luminosity evolution, QSOs, microwave background radiation, and nucleosynthesis and the origin of galaxies. 79 references. (UK)

58667 ON THE NATURE OF MASS. Hoyle, F.; Narlikar, J. V. (Cambridge Univ., Eng.). Nature (London); 233: No. 5314, 41-4(3 Sep 1971).

It is stated that the increasing number of observations of discrepant redshifts means that no longer can these be passed off as chance juxtapositions. A possible explanation of the data is given in terms of a theory that incorporates a gravitational "constant" that is decreasing with time. (auth) (UK)

58668 FRAGMENTATION OF SUPERMASSIVE DISKS. Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). Nature (London) Phys. Sci.; 233: No. 36, 5-7(6 Sep 1971).

Supermassive rotating disks, invoked by some models for quasars and active nuclei of galaxies, are unstable against fragmentation. A hierarchy of successive fragmentation into smaller and smaller pieces is described. Questions are raised about pulsar-like and gravitational radiation, which become important at the later stages of fragmentation. (auth) (UK)

58669 QUALITATIVE COSMOLOGY. Collins, C. B.; Stewart, J. M. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 153: No. 4, 419-34(1971).

The role of dissipative processes in the early Universe, in accordance with the "chaotic cosmology programme" outlined by Misner is discussed. The conclusions drawn are that (i) for arbitrary initial conditions the shear anisotropy could be arbitrarily large now; (ii) the Universe need not have been in thermal equilibrium during the early stages; and (iii) matter effects are unimportant in most, but not all, of the cosmological models considered. These results are valid for a moderately large class of nonrotating spatially homogeneous cosmologies, and so considerably extend the earlier work of Stewart. (auth) (UK)

58670 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON THERMODYNAMICS, CARDIFF, WALES, 1–4 APRIL 1970. Pure Appl. Chem.; 22: No. 3-4, 429-500(1970). (CONF-700446).

The conference papers were divided into six sections, of which one, statistical thermodynamics in Astrophysics and Relativity, was within the scope of NSA. This section comprised seven papers for which separate abstracts were prepared. (UK)

For abstracts of individual papers see: 58520, 58521, 58671–58674, and 59238.

58671 TIME ASYMMETRY IN ELECTRODYNAMICS AND COSMOLOGY. Narlikar, J. V. (Cambridge Univ., Eng.). Pure Appl. Chem.; 22: No. 3-4, 449-56(1970).

From International conference on thermodynamics; Cardiff, Wales (1 Apr 1970).

The concept of the "arrow of time" is discussed in relation to thermodynamics, electrodynamics, and cosmology. Time symmetric electrodynamics, the absorber theory of radiation, and quantum transitions are discussed and a working theory developed applicable to a Universe with a perfect future absorber and an imperfect past absorber, such as the steady state cosmological model. It is stated that the approach adopted establishes a strong connection between the electrodynamic and cosmological arrows of time, and points a way toward linking these arrows with the thermodynamic one. (auth) (UK)

58672 COSMIC EVOLUTION AND THERMODYNAMIC IRREVERSIBILITY. Layzer, David (Harvard Univ., Cambridge, Mass.). Pure Appl. Chem.; 22: No. 3-4, 457-68(1970).

From International conference on thermodynamics; Cardiff, Wales (1 Apr 1970).

Three macroscopic arrows of time are discussed: the thermodynamic arrow, defined by entropy-generating processes in closed systems, the historical arrow, defined by information-generating processes in certain open systems, and the cosmological arrow, defined by the cosmic expansion. (auth) (UK)

58673 CARNOT CYCLES FOR GENERAL-RELATIVISTIC SYSTEMS. Ebert, R. (Univ., Wuerzburg, Ger.). Pure Appl. Chem.; 22: No. 3-4, 481-6(1970).

From International conference on thermodynamics; Cardiff, Wales (1 Apr 1970).

A generalization of ordinary Carnot cycles is given for thermodynamic systems with stationary gravitational fields. The two heat reservoirs are assumed to be located at different points in space. In addition to the standard change of thermodynamic quantities the Carnot engine is allowed to change its position during the cycle. A "generalized Carnot cycle" is then defined by the following process: (1) Connection of the Carnot engine with the first heat reservoir (exchanging heat), (2) Change of position of the Carnot engine from the first to the second heat reservoir, (3) Connection of the Carnot engine with the second heat reservoir (exchanging heat), (4) Change of position of the Carnot engine from the second to the first heat reservoir, after which the cycle repeats. In all changes of position the presence of the gravitational field has to be considered. The special case of an ordinary Carnot cycle is obtained when there is no gravitational field or when the heat reservoirs are located at the same point. Under the assumption that gravitation can be described by general relativity the efficiency of these generalized Carnot cycles is calculated for stationary fields. Thermodynamic equilibrium exists when the efficiency of a generalized Carnot cycle operating between any two parts of the system is zero. For this case it is found that $T \cdot \|\xi\|$ is a constant independent of position. As used here T is the ordinary thermodynamic temperature and $\|\xi\|$ denotes the norm field of the Killing vector field ξ, representing the stationarity of the gravitational field. The proof is independent of the field equations of general relativity. Consequently equilibrium consists of a temperature field which depends on the gravitational field. For static fields with spherical symmetry Tolman has proved this relation by using the field equation of general relativity. The results show that this relation holds quite generally for arbitrary stationary fields. (auth) (UK)

58674 VARIATIONAL FORMULATION OF RELATIVISTIC FLUID THERMODYNAMICS. Schmid, L. A. (Goddard Space Flight Center, Greenbelt, Md.). Pure Appl. Chem.; 22: No. 3-4, 493-500(1970).

From International conference on thermodynamics; Cardiff, Wales (1 Apr 1970).

As a first step toward generalizing reversible thermodynamics from the case of a homogeneous system to that of a system whose local velocity may be a function of its position in space–time, a variational principle is derived for relativistic reversible adiabatic flow of a compressible fluid. This variational principle yields the correct form of the stress–energy tensor for reversible adiabatic flow of a compressible fluid (together with the necessary statements of particle and entropy conservation), and automatically gives the expression for the solution of Euler's equation of motion for the fluid in terms of the four-gradients of the generalized coordinates. (UK)

Planetary Phenomena

Refer also to abstracts 58856 and 59605.

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58675 PHASE DIAGRAMS OF HYDROGEN AND HELIUM. Trubitsyn, V. P. (Inst. of Geophysics, Moscow). Sov. Astron. AJ (Engl. Transl.); 15: No. 2, 303-9(Sep-Oct 1971).

Translated from Astron. Zh.; 48: No. 2, 390-8(Mar-Apr 1971).

The thermodynamic properties and phase diagrams of hydrogen and helium are discussed for pressures found in the interiors of Jupiter and Saturn. (auth)

58676 IONOSPHERE OF MARS BELOW 80 km ALTITUDE. II. SOLAR COSMIC-RAY EVENT. Whitten, R. C. (Ames Research Center, Moffett Field, Calif.); Poppoff, I. G.; Sims, J. S.; (and others). Planet. Space Sci.; 19: No. 8, 971-9(Aug 1971).

Models of the lower ionosphere of Mars during a solar proton event are developed using ion chemistry previously proposed (1970). The computed electron number densities for two representative proton spectra appear to be large enough to easily allow the determination of the entire profiles of electron concentration by means of a bistatic radar occultation experiment. (auth) (UK)

58677 NEW MOON: A VIEW. Hinners, N. W. (Bellcomm, Inc., Washington, D. C.). Rev. Geophys. Space Phys.; 9: No. 3, 447-522(Aug 1971).

New Moon data from Apollo 11, 12, and 14 and Luna 16 allows detailed analyses to be made of lunar data. It appears that the Moon originated about 4.6 b.y. ago, as did the Earth and meteorites, thus at the beginning of the solar system. The igneous processes that resulted in flooding of the mare basins with basaltic lavas are now understood, as are the effects of meteoroids in generating the shallow surficial soil or regolith. Other lunar materials studied include breccias, anorthosites, Kreep, mesotasis, granitic materials, lunar carbon, organic matter, tektites, meteorites, "life", and Rock 12013. Discussions on lunar chronology, lunar-surface processes, and global aspects of the moon are given featuring the latest data. Noble gases in lunar soil are known to be of solar-wind origin. 212 references. (J.C.W.)

58678 LUNAR ROCKS. Mason, Brian. Sci. Amer.; 225: No. 4, 49-58(Oct 1971).

Results from studies of Apollo 11, 12, and 14, and Luna 16 samples are reviewed. Topics considered include classification, mineralogy, texture, significance of the findings, and volcanism on the Moon. (W.D.M.)

58679 LUNAR ATMOSPHERE. Johnson, Francis S. (Univ. of Texas, Dallas). Rev. Geophys. Space Phys.; 9: No. 3, 813-23 (Aug 1971).

A rarefied atmosphere should be present on the moon because of contributions from the solar wind, meteoric volatilization, and internal degassing. Transient contributions to the atmosphere must be produced by rocket gases during lunar missions. These gases may obscure the ambient atmosphere in the vicinity of the landing site for a period of several months after a lunar landing. Of the three natural sources, definite predictions can be made only on the basis of solar-wind input. The lunar atmosphere of solar origin is expected to consist mainly of neon; lighter gases are less prevalent because of their more rapid thermal escape and are less prevalent because of their lesser concentrations in the solar wind. Daytime neon concentrations are expected to be near 6×10^4 cm^{-3}, and nighttime concentrations are expected to be near 1.5×10^6 cm^{-3}. 26 references. (auth)

58680 DISTRIBUTION OF ^{222}Rn ON THE SURFACE OF THE MOON. Heymann, D.; Yaniv, A. (Rice Univ., Houston, Tex. Tel Aviv Univ, Israel). Nature (London) Phys. Sci.; 233: No. 37, 37-9(13 Sep 1971).

It is believed that the considerations discussed may have interesting implications for the α-spectrometry experiments planned for the command module of the later Apollo flights. The most important of these considerations is the sticking time, τ, of ^{222}Rn atoms on regolith materials. If τ is much greater than about 10^2 s, then ^{222}Rn cannot migrate far from its point of release, since it will be strongly adsorbed on the surface. If, however, τ is much smaller than 10^2 s, no adsorption occurs and ^{222}Rn will become more or less uniformly distributed across the entire Moon. The value of τ for ^{222}Rn on regolith material has not been measured and it is difficult to estimate it accurately. The conditions required to produce either a uniform ^{222}Rn distribution or a ^{222}Rn pile-up are considered. Strong adsorption of ^{222}Rn on the sunlit side is considered very unlikely, but pile-ups may be expected to occur at the terminator. A simple model is suggested. It is considered that detailed analysis of the experimental data from the Apollo flights may provide a reasonably accurate value for the heat of adsorption of Rn on regolith material, which is needed for calculating Rn diffusion and escape from the regolith itself, which in turn has implications for U, Th–Pb dating of lunar samples. (UK)

Atomic and Molecular Physics

58681 EMISSION OF SLOW POSITRONS FROM DIELECTRIC ABSORBERS, STATISTICAL VARIATIONS IN THE ELECTROSTATIC POTENTIAL MEASURED OUTSIDE OF A REAL CONDUCTING SURFACE AND STIMULATED EMISSION OF MAGNETIC BREMSSTRAHLUNG. Madey, John Michael Julius. Stanford, Calif.; Stanford Univ. (1971). 206p. University Microfilms Order No. 71-19,724.

Thesis.

Part I summarizes the background and analyzes the results of a survey designed to detect the emission of low-energy positrons from mica and polyethylene absorbers irradiated by the energetic positrons from a millicurie level ^{58}Co source. A measurable flux of slow positrons was found to be emitted from a polyethylene absorber whose crystallite structure had been preferentially oriented relative to the surface. In Part II, an analysis is presented of the statistical properties of the electrostatic potential and the electric field outside of a real conducting surface due to the random exposure at the surface of crystal planes with differing work functions. Two cases are considered, corresponding to the potential measured outside of a conducting cylindrical tube. Taking the boundary conditions explicitly into account, expressions are developed for the first and second moments of the potential and the field. In Part III, the Weizsäcker–Williams method is used to calculate the gain due to the induced emission of radiation into a single electromagnetic mode parallel to the motion of a relativistic electron beam through a periodic transverse dc magnetic field. Finite gain is available from the far-infrared through the visible region, raising the possibility of continuously tunable amplifiers and oscillators at these frequencies with the further possibility of partially coherent radiation sources in the ultraviolet and x-ray regions to beyond 10 keV. Several numerical examples are considered. (TSS) (Diss. Abstr. Int., B)

58682 TOPICS IN MODERN PHYSICS: A TRIBUTE TO EDWARD U. CONDON. Brittin, Wesley E.; Odabasi, Halis (eds.). Boulder, Colo.; Colorado Associated University Press (1971). 391p. $17.50.

The twenty-two papers of this volume were prepared as a tribute to Prof. E. U. Condon by his associates on the occasion of his becoming professor emeritus in the Department of Physics, Univ. of Colorado, in the summer of 1970. The collection covers a wide range of topics, reflecting the many different areas of physics actively studied by Condon. An individual abstract was prepared for the twelve papers in scope for NSA. (L.M.T.)

For abstracts of individual papers see: 58618, 58619, 58715–58718, 58815, 58816, 59234, 59235, 59447, and 59793.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 58266, 59107, 59146, 59560, and 59685.

58683 (FRNC-TH-49) SECONDARY ELECTRON EMISSION FROM GERMANIUM UNDER ELECTRON BOMBARDMENT. Touzillier, Lucien (Toulouse Univ. (France). Faculte des Sciences). 1970. 110p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Secondary emission from platinum was briefly studied. A more detailed investigation of secondary emission from germanium was then made using the target temperature as a parameter. The influence of the target temperature on secondary emission from metals and semiconductors was studied, and an attempt was made to obtain information on the secondary-emission mechanism. An attempt was also made to relate this secondary emission to the structure of the solid by means of electronic transitions. A comparison was made between the results obtained and those associated with photoemission, the analogy between discrete energy losses from a beam of electrons and optical spectra being well established. (France)

58684 DETERMINATION OF PHOTOIONIZATION CROSS SECTIONS IN VARIOUS ATOMIC MODELS. Combet-Farnoux, F. (Univ., Paris). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.203-9(Nov-Dec 1970). (In French).

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

It is shown that a single-electron model with a central potential is sufficient to account for the existence of a resonance maximum, near the ionization threshold, in the cross sections of certain subshells. The amplitude and position of this maxima vary with Z. A comparison is made between σ_{4d} values obtained using two different central potentials (Herman and Skillman potential and McKlapischs parametric potential). It is also shown how a simple model with a central potential can be used to introduce core relaxation in the atom after ionization, exchange effects between the ejected electron and the core, and certain correlation effects (interchannel interactions). (auth) (France)

58685 DEPTH DISTRIBUTION OF CHARACTERISTIC X-RAY PRODUCTION IN COPPER BY 12- TO 30-keV ELECTRONS. Duerr, G.; Hofer, W. O.; Schulz, F.; Wittmaack, K. (Institut fuer Strahlenschutz, Munich). Z. Phys.; 246: No. 4, 312-22 (1971). (In German).

The depth distribution of characteristic x-ray production in copper by 12- to 30-keV electrons was measured with a zinc tracer. The results are examined in terms of characteristic distribution parameters, which show a potential-law energy dependence. Reduction of the depth data and the electron energies by means of electron range and excitation energy, respectively, allows comparison with experimental and theoretical results of other authors on various target—tracer combinations. Although a general energy dependence is found for the majority of the reduced characteristic parameters, the accuracy of the data is not satisfying. Some of the measured distributions obviously contain large systematic errors. (auth)

58686 TRANSITION RADIATION AND OPTICAL PROPERTIES OF EVAPORATED CARBON FOIL. DiNardo, R. P.; Goland, A. N. (Brookhaven National Lab., Upton, N. Y.). J. Opt. Soc. Amer.: 61: No. 10, 1321-4(Oct 1971).

The light emitted from an electron-irradiated self-supported foil (334 ± 30 Å) of evaporated carbon was investigated experimentally. Normally incident 1-μA electron beams having monochromatic energies of 297, 423, 632 keV, and 1.10 MeV were used. These correspond to β^2 values of 0.6, 0.7, 0.8, and 0.9, respectively, where $\beta = v/c$, and v is the velocity of the incident electrons. The absolute photon intensity emitted in the 2200 to 5800-Å spectral region was measured with a calibrated optical system. The results were analyzed with respect to wavelength of emitted radiation, forward angle of emission, θ (15° and 30°), and degree of polarization (parallel and perpendicular to the plane of the incident electrons and observed light). The transition-radiation contribution determined from the parallel-polarized component was compared with the generalized theory of Ritchie and Eldridge, using the optical constants of graphite and glassy carbon. From this comparison and a best-fit calculation, the optical constants for the carbon film throughout the 2200 to 5800-Å spectral region were derived. The derived constants indicate that the carbon film has optical properties between those of graphite and glassy (amorphous) carbon. The results obtained stress the importance of measuring the optical constants of a given carbon film for any experiment in which they are needed. (auth)

58687 SCATTERING OF POLARIZED ELECTRONS FROM MAGNETIC MATERIALS. Vriens, L. (Philips Research Labs., Eindhoven, Netherlands). Phys. Rev., B; 4: No. 9, 3088-93 (1 Nov 1971).

Cross-section formulas for large-angle (e,e) and for coincidence (e,2e) scattering of fast electrons from gaseous and solid targets are derived. It is shown that the momentum- and spin-density distribution of the bound electrons can be obtained from single (e,e) scattering of polarized electrons. It is also shown that the electronic spin- and energy-dependent momentum-density distribution can be obtained from (e,2e) scattering of polarized electrons. An (e,2e) experiment with unpolarized electrons gives the energy-dependent momentum distribution. A comparison is made with related methods, like Compton scattering, and the feasibility of the suggested experiments is discussed. (auth)

58688 APPROXIMATE SOLUTION OF A BOUNDARY-VALUE PROBLEM FOR AN ELECTRON CURRENT IN CROSSED FIELDS. Mikulin, A. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 538-41(Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 687-91(Apr 1971).

Neutralization of ion space charge by an electron beam in crossed magnetic and electric fields is considered. The problem is put into a form suitable for approximate solution by substitution of variables and functions for the case in which the potential variation in the space between the electrodes is monotonic. (auth)

58689 LOW-ANGLE SCATTERING OF ENERGETIC IONS FROM AN AMORPHOUS SURFACE. Marwick, A. D.; Thompson, M. W.; Farmery, B. W.; Harbinson, G. S. (Univ. of Sussex, Brighton, Eng.). Radiat. Eff.; 10: No. 1-2, 49-54(Jul 1971).

Ions of hydrogen and helium at 275 keV were scattered from a flat surface composed of amorphous tungsten oxide prepared by anodization. Measurements of the angular distribution and the energy spectrum were conducted for various angles of incidence and angles of scattering up to 5°. The observations are compared with the predictions of a plural scattering theory and good agreement is found. In particular, the most probable energy loss of the scattered ions is proportional to the scattering angle, the angular distribution of ions scattered with any particular energy loss is roughly a gaussian function truncated by the surface plane while the energy spectrum has nearly the predicted form of a skewed peak. (auth)

58690 INTERACTION OF GAS ATOM WITH A HOT SOLID SURFACE: HARMONIC-MODEL ANALYSIS. Forman, R. E. (Brown Univ., Providence). J. Chem. Phys.; 55: No. 6, 2839-48(15 Sep 1971).

The interaction of a monoenergetic gas beam with a hot surface is viewed as a collection of discrete two-body collisions. By use of a soft-cube model with a truncated harmonic interaction potential, the interaction is reduced to a linear problem. The solution to this simplified view indicates that an important role of thermal motion of the solid atoms is reflected in the distribution of their initial conditions at the time interaction begins. Specifically, the initial-condition distribution is biased toward interactions beginning with greater than average relative velocity between gas and solid atoms. The average exit velocity of the gas is expressed as an integral over the initial-condition distributions. This integral cannot be evaluated exactly in closed form and an approximate analytical evaluation is obtained. A computer simulation of the problem was devised and shows satisfactory agreement with the theoretical value for the average relative velocity at the start of interaction and the analytical approximation for the average gas exit velocity. (auth)

58691 FORMATION AND LORENTZ IONIZATION OF HIGHLY EXCITED ATOMS. Il'in, R. N. (Ioffe Inst. of Physics and Tech., Leningrad). pp 113-32 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Properties of highly excited atoms and mechanisms of ionization in electric fields are reviewed. Methods of production of highly excited atoms are surveyed. Emphasis is on charge-transfer processes; results for various gaseous and metal-vapor targets are compared. 27 references. (A.G.W.)

58692 NONRADIATIVE PROCESSES AT SOLID SURFACES. Hagstrum, H. D. (Bell Telephone Labs., Murray Hill, N. J.). pp 190-210 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Electronic transition processes that occur in a system of a solid and an atomic particle when the particle is slowly approaching the solid surface are reviewed. The two-electron Auger processes and the resonance processes that can act as precursors to them are discussed in terms of electron-energy and potential-energy diagrams. The current state of knowledge of the Auger ejection process is summarized by a series of questions and answers. An experimental method for study of ion neutralization at solid surfaces is described briefly, and a few typical results are included. The use of Auger neutralization as a tool in studying solid surfaces is considered. (A.G.W.)

58693 SPUTTERING. Thompson, M. W. (Univ. of Sussex, Brighton, Eng.). pp 211-22 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Effects of factors such as ion energy, temperature, and angle of incidence on sputtering yields are reviewed. Methods of measurement of angular and energy distributions of sputtered particles are illustrated briefly, and some typical results are shown. (A.G.W.)

58694 SCATTERING OF HELIUM ATOMS BY PHONONS IN THE (001) SURFACE OF LiF AT 150°K. Williams, Brian R. (National Research Council of Canada, Ottawa). J. Chem. Phys.; 55: No. 7, 3220-35(1 Oct 1971).

Results are presented for the scattering of a beam of helium atoms (obtained from a nozzle source) from a cleaved lithium fluoride surface maintained at 150°K. The scattering patterns reveal two types of scattering events: (1) coherent scattering, showing a large number of diffraction peaks not reported to date,

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and (2) inelastic scattering resulting from the vibrations of surface atoms. This component of scattering is observed in the neighborhood of the elastic peaks, in the form of streaks extending in particular directions outward from the Bragg angle. The shapes of the scattering patterns obtained follow the general predictions made for bounds imposed on the scattering surface by the incident velocity of the helium atom. (auth)

58695 ELECTRON LOSS AND CAPTURE CROSS SECTIONS FOR MULTIPLY CHARGED IONS IN SOLID MATTER. Teplova, Ya. A.; Dmitriev, I. S.; Nikolaev, V. S. (Moscow State Univ.). J. Phys., B (London): 4: No. 9, L70-2(Sep 1971).

The dependence of the equilibrium charge distribution of light ions with atomic numbers Z from 4 to 8 on the film thickness was investigated for ions moving at velocities $v \simeq (8 \text{ to } 11) \times 10^8$ cm sec^{-1} in thin celluloid films. It was found that, at $U < V_0 Z$, equilibrium thickness is a function of the initial ionic charge and the electron-capture cross section for charged ions in solids is less than that in gases. (auth) (UK)

Atomic and Molecular Properties

Refer also to abstracts 58384, 58509, 58788, 59003, 59016, 59017, 59034, 59221, 59344, 59536, and 59554.

58696 THEORY OF THE QUADRATIC ZEEMAN EFFECT. Edmonds, A. R. (Imperial Coll. of Science and Tech., London). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.71-4(Nov-Dec 1970).

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

The existence of previously unobserved structures in the spectra of atoms in magnetic fields was established from high-resolution work carried out at Argonne. These structures may be attributed to a second degree term of the Hamiltonian in the magnetic field, which gives rise to a formally nonseparable problem. The relevant parameters are such as to render conventional approximations invalid. An attempt is made to overcome these difficulties. Preliminary results show promising agreement with the data. (auth) (France)

58697 4f–5d INTERACTIONS IN SAMARIUM, GADOLINIUM, AND TERBIUM. Spector, N. (Israel Atomic Energy Commission, Yavne). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.173-88(Nov-Dec 1970).

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

The newly established levels of the subconfigurations $4\ f^6(^7F)5\ d$ of singly ionized samarium (Sm II), $4f^8(^7F)\ 5d$ of singly ionized gadolinium (Gd II), and $4f^8(^7F)\ 5d\ 6s^2$ of neutral terbium (Tb I) are used to obtain reliable values for the six electrostatic (Slater), and two spin-orbit interaction parameters around the half filled 4f shell. Out of 57 possible levels in each case, 54 of sm^+, 45 of Gd^+, and 27 of Tb are fitted with an rms error of 168 cm^{-1} (1.24% of total width), 239 cm^{-1} (1.76%), and 152 cm^{-1} (1.76%), respectively. L–S coupling notations can be used for level designations despite some heavy admixtures. Eigenvectors differing significantly from previously published valves as well as predictions for missing levels are tabulated. About 70 Gd II lines are classified. (auth) (France)

58698 ACCURATE ANALYTICAL SELF-CONSISTENT-FIELD WAVE FUNCTIONS FOR Dy^{2+}. Synek, M.; Ramirez, R. (Texas Christian Univ., Fort Worth). J. Chem. Phys.; 55: No. 4, 1946-8(15 Aug 1971).

Accurate analytical self-consistent-field (SCF) wave functions were calculated for the dysprosium laser-active ion, namely for Dy^{2+} (Z = 66), $4f^{10}$, ^5I. These ab initio calculations were done by the analytical SCF expansion method, with full exchange effects for all the 64 electrons included. All of the basis function exponents in the analytical expansions were exhaustively optimized. These results represent the only analytical wave functions for Dy^{2+} available at this time. The usual accuracy criteria were satisfied in these calculations. (auth)

58699 ELECTRONIC TRANSITION MOMENT OF THE LYMAN BANDS OF H_2 ($B^1\Sigma_u^+ - X^1\Sigma_g^+$ AS A FUNCTION OF INTERNUCLEAR SEPARATION. Marchetti, M. A.; La Paglia, S. R. (Georgetown Univ., Washington, D. C.). J. Chem. Phys.; 55: No. 4, 1655-61 (15 Aug 1971).

The LCAO–MO–CI method is applied to the study of the electronic transition moment of the Lyman bands of H_2 ($B^1\Sigma_u^+ - X^1\Sigma_g^+$) over the range of internuclear separations $1 \leq R \leq 6$ a.u. It is found that configuration interaction is responsible for a strong nonlinear variation of the transition moment with internuclear distance (maximum transition moment at 3.0 a.u.). Comparison with other calculations indicates that the method is applicable to more complicated molecules and permits the examination of how individual electron correlation effects contribute to the transition moment. (auth)

58700 LABORATORY DETERMINATION OF THE FREQUENCY OF THE 10 CENTIMETER RADIO LINE OF CH BY OPTICAL MEASUREMENTS. Baird, K. M.; Bredohl, H. (National Research Council, Ottawa). Astrophys. J.; 169: No. 2, L83-6(15 Oct 1971).

A new method of photographic Fabry–Perot interferometry was used to measure the Λ doubling of the $J = \frac{1}{2}$ level in the electronic ground state of CH. The value of 3374 ± 15 MHz agrees with Douglas and Elliott's extrapolated value but not with Miller Goss's direct measurements. (auth)

58701 ANALYSIS OF THE ARC AND SPARK SPECTRUM OF SCANDIUM. Neufeld, Lorin Wesley. Manhattan, Kan.; Kansas State Univ. (1970). 139p. University Microfilms Order No. 71-17,365.

Thesis.

Reanalysis and extension were made of the arc and spark spectra of scandium. Observations were made with a 3.4-meter Ebert-type spectrograph. It has a dispersion approximately twice that obtained in previous work on scandium. A total of nearly 1,600 lines are reported, about twice the number previously reported. They were measured with a probable error of from 3mÅ in the ultraviolet to 10mÅ in the near infrared. Using previously published energy level values, finding lists were constructed for ScI and ScII. All lines fitting into one of these level systems were then identified. The remaining unclassified lines were then used in a computer search for new levels. A total of 22 new high even and 2 high odd levels are added to the ScI level system. No new levels are added to the Sc II level system. A total of 138 lines are classified in the Sc II level system and 634 lines are classified in the Sc I level system. The classified lines were then used to determine new values for the energy levels. Exposures were obtained with the scandium electrodeless discharge lamp in a magnetic field. From these exposures, the Zeeman effect was observed and measured. The g-values for 18 Sc II levels and for 71 Sc I levels are reported. A total of 14 published Sc I levels are determined to be false and are removed from the energy level list. A comparison is made with the recent theoretical calculations of level values and g-values for both Sc I and Sc II. (Diss. Abstr. Int., B)

58702 EXCHANGE PERTURBATION THEORY AND THE HeH^+ ION. Certain, Philip R. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 55: No. 6, 3045-6(15 Sep 1971).

It is demonstrated that when exchange perturbation theory is applied to the first two excited states of the molecular ion HeH^+ the first-order theory does not give even the correct sign of the exchange energy for the two states. It is pointed out that in this case the zero-order wave function is not necessarily orthogonal to lower zero-order wave functions and that the first-order energy may predict too large a binding energy (or too small a repulsion) for the excited state. The energy may be corrected by going to higher order, but this introduces the mathematical problems of overcompleteness when both covalent and ionic terms are included. (A.G.W.)

58703 SYMMETRY OF EXCITED ELECTRONIC STATES IN URANYL NITRATE CRYSTALS. Komyak, A. I. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 2, 85-8(1969). (In Russian).

On the basis of the absorption spectra of uranyl nitrate crystals at room and low (77°K) temperatures, the symmetry of four electronic excited states of the uranyl ion is discussed. In uniaxial crystals ($RbUO_2(NO_3)_3$, $CsUO_2(NO_3)_3$, and $NH_4UO_2(NO_3)_3$) the designation of types of symmetry was carried out in agreement with the point group D_{3h}, and in biaxial crystals with D_{2h}. According to neutron-diffraction data, higher symmetry (D_{6h}) is not realized in uranyl nitrate crystals. Comparison with types of symmetry reported in the literature was carried out. (tr-auth)

58704 GREEN'S FUNCTION FOR THE HYDROGEN MOLECULAR ION H_2^+. Laurenzi, Bernard J. (State Univ. of New York, Albany). J. Chem. Phys.; 55: No. 6, 2681-4(15 Sep 1971).

The exact Green's function for the one-electron two-center molecule H_2^+ was found. It is a remarkably mild generalization of the well-known Green's function for the atom He^+. (auth)

58705 PRESENT STATE OF THE ANALYSIS OF Nd I AND Nd II. Blaise, J. (CNRS, Orsay, France); Wyart, J. F.; Hoekstra, R.; Kruiver, P. J. G. J. Opt. Soc. Amer.; 61: No. 10, 1335-42(Oct 1971).

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Nd I and Nd II spectra emitted by an electrodeless tube were observed between 2450 and 40,500 Å. By means of 25,000 wavelengths measured with an automatic comparator and of the Zeeman patterns of the strongest lines, about 1500 energy levels were found. Their interpretation was carried out with the use of isotopic-shift data and empirical parametric calculations. The present state of the classification is described. The main features of the 15 known configurations and some results of theoretical calculations are given. (auth)

58706 CONFIGURATIONS $4f^{N-1}6s^2 6p$ IN NEUTRAL GADOLINIUM, DYSPROSIUM, ERBIUM, AND YTTERBIUM. Spector, Nissan (Israel Atomic Energy Commission, Yavne). J. Opt. Soc. Amer.; 61: No. 10, 1350-4(Oct 1971).

The groups of six levels obtained by adding, in J−j coupling, a 6p electron to the lowest level of the $4f^{N-1}$ core were identified in gadolinium, dysprosium, erbium, and ytterbium (N = 8, 9, 12, 14). They account for strong transitions to the corresponding $4f^{N-1}5s6s^2$ configurations. Values for the spin−orbit parameter of the 6p electron are (in cm^{-1}) $\zeta_p = 1835, 1840, 2049, 2257$, respectively. (auth)

58707 RESONANCE LINES OF La III. Johansson, Sveneric; Litzen, Ulf (Univ. of Lund, Sweden). J. Opt. Soc. Amer.; 61: No. 10, 1427-8(Oct 1971).

The 5d−4f lines of La III were recorded, and the wave numbers obtained were used for calculating energy levels. The accuracy of the new energy levels is estimated to be better than 0.02 cm^{-1}. (A.G.W.)

58708 SPECTRA OF NEUTRAL AND SINGLY IONIZED HOLMIUM. Livingston, A. E. Jr.; Pinnington, E. H. (Univ. of Alberta, Edmonton). J. Opt. Soc. Amer.; 61: No. 10, 1429-30 (Oct 1971).

The techniques of Zeeman-effect analysis, hyperfine-structure measurement, and computer searching for repeating energy differences were applied to the spectra of Ho I and Ho II. The eight patterns in the Zeeman-effect spectrum of Ho I that were resolved and sufficiently complete to yield g values are tabulated. No resolved Zeeman patterns for Ho II were found. A computer search based on the 547 Ho II lines contained in the NBS list yielded 10 pairs of lines having wave-number differences near 637.8 cm^{-1} and hfs-width differences near 3.1 cm^{-1}. On the basis of these results, 10 excited-state levels are proposed. (A.G.W.)

58709 THEORETICAL CALCULATION OF ENERGY LEVELS FOR RARE EARTH ELEMENT IONS. Shadzhyuvene, S. D.; Surgailene, R. T.; Ripskite, P. V.; Bogdanovichyus, P. O.; Karaziya, R. I. (Inst. of Physics and Mathematics, Vilnyus, USSR). Liet. Fiz. Rinkinys; 10: No. 6, 873-86(1970). (In Russian).

Using radial integrals calculated by the Hartree−Fock method, the energy levels for Ce III, Pr III, Pr IV, and Nd IV involving one open $4f^N$(N = 2, 3) shell are theoretically determined. The energy spectra obtained are discussed and compared with experimental and semi-empirical results. A program for the BESM-4 computer allowing one to calculate the energies of free atoms and ions, containing one or two open shells, is described. (auth)

58710 ATOMIC WAVE FUNCTIONS USEFUL FOR MOLECULAR CALCULATIONS: SOME STATES OF THE He ATOM. Gupta, B. K. (Osmania Univ., Hyderabad, India). Indian J. Pure Appl. Phys.; 9: No. 4, 261-2(Apr 1971).

Atomic wave functions for the ground 1^1S and excited 2^3S, 2^1P, and 2^3P states of the He atom are reported. The wave functions, obtained using a limited number of configurations, are constructed by forming bond functions from Slater determinants and projecting them for the appropriate state, using configuration interaction. Full optimization of the nonlinear parameters was carried out. The wave functions described are particularly suited for use in calculations for molecules in which the He atom, in one or more of the above states, forms a constituent part. The energies calculated using these wave functions compare well with those obtained from earlier calculations. (auth)

58711 $\sigma-\pi$ SEPARATION: EXCITED H_2 AS A MODEL SYSTEM. Zemke, Warren T. (Illinois Inst. of Tech., Chicago). Theor. Chim. Acta; 22: No. 1, 23-38(1971).

The low-lying Π states of H_2 consist of one core (σ) and one valence (π) electron and afford a direct evaluation of intershell $\sigma-\pi$ interaction. After resolution of the electronic energy into σ only, π only, and $\sigma-\pi$ parts, it is shown that an electronic change in this model system is due solely to a change in the π electrons. Simple Hückel theory is examined. If the molecular core is represented properly, regardless of the π wave function the calculated α and β parameters are in reasonable agreement with the "empirical" parameters. This agreement appears to be due to a fortuitous cancellation of energy contributions. (auth)

58712 FIRST ORDER DENSITY MATRICES FROM CONFIGURATION INTERACTION WAVEFUNCTIONS FOR H_3^+. Duben, Anthony Joseph. University Park, Pa.; Pennsylvania State Univ. (1970). 138p. University Microfilms Order No. 71-16,594. Thesis.

Four configuration-interaction calculations were performed on the $D_{3h}H_3^+$ ion using a Gaussian lobe basis. Both single and double excitations were considered. The best calculation has an energy of −1.34050 hartrees at an internuclear distance of 1.6405 bohrs. Various one-electron molecular properties and plots of the electron density were determined for each wave function. Analyses of the wave functions by both the density-matrix−natural-orbital and the Sinanoglu theories show that single excitations are not negligible with respect to the double excitations in determining the electron density and in the calculation of one-electron properties. In addition, the corrections to the electron density due to the single excitations and due to the double excitations are essentially separable effects. The double excitations tend to shift electron density out away from the molecule. The single excitations tend to return electron density to the region of the molecular framework, especially in the vicinity of the nuclei themselves. (Diss. Abstr. Int., B)

58713 HULTHEN TRANSFORM FUNCTIONS FOR THE EXCITED STATES OF TWO-ELECTRON ATOMS. Gruninger, John (West Virginia Univ., Morgantown). J. Chem. Phys.; 55: No. 7, 3561-3(1 Oct 1971).

Hulthén functions are used to approximate the 2p and 3d orbitals of the lowest ^1P, ^3P, ^1D, and ^3D states of helium and to approximate the 2p orbitals of the lowest ^3P states of the two-electron ions of Li, Be, and B. The orbital approximations and energies of the singlet states obtained using Hulthén 1p and 2d functions are identical to those obtained by Chong from minimal basis Slater 2p and 3d functions. The Hulthén 1p functions differ significantly from the Slater 2p functions only for the ^3P states. The energies obtained for the ^3P states are lower than those obtained from the minimal basis Slater functions. Using the new results for the ^1P and ^3P states of He, a term separation of 0.0087 a.u. is obtained. This value is in close agreement with the Hartree−Fock value of 0.0088 a.u. (auth)

58714 ELECTRONIC RECOMBINATION COEFFICIENT OF MOLECULAR HELIUM IONS. Johnson, A. Wayne; Gerardo, J. B. (Sandia Labs., Albuquerque, N. Mex.). Phys. Rev. Lett.; 27: No. 13, 835-8(27 Sep 1971).

The effect of metastable−metastable ionizing collisions has been neglected in previous measurements of the electronic recombination coefficient of molecular helium ions. In this study, a source of free electrons was taken into account and the recombination coefficient was observed to be much larger than previously reported. Over the pressure range from 15 to 50 torr, this coefficient was measured to range from $(1.8 \text{ to } 4.3) \times 10^{-8}$ cm^3 sec^{-1}. (auth)

58715 IONIZATION POTENTIALS OF ATOMS AND IONS CONTAINING ONE TO TEN ELECTRONS. Edlen, Bengt (Lund Univ., Sweden). pp 133-45 of Topics in Modern Physics. /Brittin, Wesley E. (ed.). Boulder, Colo.; Colorado Associated Univ. Press (1971).

With increasing degree of ionization, accurate ionization potentials can be obtained by direct observations for only a limited number of spectra in the beginning of each isoelectronic sequence; for the rest, extrapolations must be used. Since the author discussed this problem at length earlier (J. Chem. Phys., 33: 98 (1960)) a wealth of new experimental data has become available, and much progress has been made from the theoretical side. Therefore, the subject is reviewed here after collecting experimental and theoretical results for confrontation and synthesis. The discussion is limited to the first ten electronic systems, the only ones for which reasonably definite results can be given at the present time. 30 references. (L.M.T.)

58716 Z DEPENDENCE OF SPIN−ORBIT COUPLING. Fano, U. (Univ. of Chicago); Martin, W. C. pp 147-52 of Topics in Modern Physics. /Brittin, Wesley E. (ed.). Boulder, Colo.; Colorado Associated Univ. Press (1971).

The systematic variation of the spin−orbit coupling strength along the periodic system is discussed. The main point is displayed in a plot of suitably reduced values of the p-electron coupling strength. The data are experimental values for configurations of the type (core)np in neutral atoms. These values are clustered along a straight line in a log−log plot against the atomic number Z. The line's slope is ~2.33. (auth)

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58717 BEUTLER–FANO SHAPE IN THE PREDISSOCIATION OF H_2. Herzberg, G. (National Research Council of Canada, Ottawa). pp 191-7 of Topics in Modern Physics. /Brittin, Wesley E. (ed.). Boulder, Colo.; Colorado Associated Univ. Press (1971).

From recent studies of the far-ultraviolet absorption spectra of H_2 and D_2 the author reports some striking examples of Beutler–Fano shapes in predissociation, a phenomenon not observed before. (L.M.T.)

58718 TRANSITION PROBABILITIES AND FRACTIONAL OCCUPATION NUMBERS IN ATOMS. Slater, J. C. (Univ. of Florida, Gainesville). pp 297-303 of Topics in Modern Physics. /Brittin, Wesley E. (ed.). Boulder, Colo.; Colorado Associated Univ. Press (1971).

The author and collaborators have earlier pointed out the usefulness of a statistical exchange for calculations of self-consistent fields in crystals, and incidentally in atoms. One of the characteristics of the use of the statistical exchange is that the eigenvalues, representing one-electron energies, do not agree well with the Hartree–Fock values or with experimental excitation and ionization energies; the explanation of this has been pointed out in terms of the use of fractional occupation numbers of electrons in the various orbitals. It is now possible to tie together some of the properties of the statistical exchange and the fractional occupation numbers more effectively than was done heretofore, as the author and Wood (Int. J. Quant. Chem., 4S: 3(1971)) have shown. In this note the interesting application of the ideas developed earlier to the calculation of transition probabilities in atoms is pointed out. (auth)

58719 FLUORESCENCE, AUGER, AND COSTER–KRONIG L_{II} SUBSHELL YIELDS OF THORIUM. Ferreira, J. G.; Soares, J. C.; Barroso, A.; Gil, F. B. (Univ. of Lisbon). J. Phys., A (London); No. 5, 679-84(Sep 1971).

Fluorescence (ω_2), Auger (a_2), and Coster–Kronig (f_{23}) L_{II} subshell yields in thorium were determined from measurement of L x rays emitted following α decay of ^{232}U. α–x coincidence techniques, employing a surface barrier detector for the α particles and a NaI(Tl) scintillation counter for L x rays, were used to measure the total fluorescence yield $\overline{\omega}_L$ of the L shell in ^{228}Th. The relative intensity of the L x photons from the L_{II} and the L_{III} subshells was determined with a Si(Li) L x ray spectrometer. The experimental results are: $\omega_2 = 0.44 \pm 0.03$; $f_{23} = 0.13 \pm 0.10$; $a_2 = 0.43 \pm 0.10$, and $\overline{\omega}_L = 0.46 \pm 0.03$. (auth) (UK)

58720 MEASUREMENT OF THE 2^3P_0-2^3P_1 FINE STRUCTURE INTERVAL OF ^4He. Kponou, Ahovi E. F. New Haven; Yale Univ. (1970). 144p. University Microfilms Order No. 71-16,503.

Thesis.

The $2^3P_0-2^3P_1$ fine-structure interval of the helium atom (He^4) was measured by the optical–microwave atomic-beam magnetic resonance method. The transition $(J,m_J) = (0,0) \rightarrow (1,0)$ was observed at a magnetic field of about 320 G. Seventy-three resonances were observed. The result is $\nu_{01} = E(2^3P_0) - E(2^3P_1) = 29\,616.862 \pm 0.033$ MHz (1.11 ppM), in which the error represents one standard deviation and is due mainly to counting statistics. This result is to be compared with $\nu_{01} = 29\,616.76 \pm 0.40$ MHz obtained by a level-crossing experiment. The present experimental accuracy (≈1 ppM) makes it possible to eventually determine the value of the fine-structure constant α to better than 1 ppM provided the theoretical expression for ν_{01}, in which α is treated as unknown, can be determined to an accuracy of at least 2 ppM. An alternative interpretation of the result is to use an independent determination of the fine-structure constant to compare measurements of ν_{12} and ν_{01} with their calculated values as a check of the theory. (Diss. Abstr. Int., B)

58721 DENSITY OF STATES IN THE STATIC SCREENED COULOMB POTENTIAL. Preist, T. W. (Univ. of Exeter, Eng.). J. Phys., B (London): 4: No. 9, 1129-39(Sep 1971).

Regge trajectories are calculated for the screened Coulomb potential with screening radii in the range 10^{-6} to 10^{-3} cm corresponding to an ionized hydrogen gas of temperature 5000°K and electron density 10^{11} to 10^{17} cm^{-3}. The Regge trajectories are used to compute the density of states as a function of energy and the results suggest a simple parametric form for this function. The calculation also yields information on the upper bound to the principal quantum number and the start of the quasi-continuum. (auth) (UK)

58722 LIFETIMES AND RELATIVE INITIAL-STATE POPULATIONS OF SOME HYDROGEN ATOMIC STATES USING BEAM-FOIL SPECTROSCOPY. Schuermann, D.; Schlagheck, W.; Heckmann, P. H.: Bukow, H. H.; Buttlar, H. v. (Ruhr-Univ., Bochum, Ger.). Z. Phys.; 246: No. 3, 239-47(1971). (In German).

H_2^+ ions or protons, accelerated to energies between 80 and 300 keV, are sent through a thin carbon target. Light emitted by the excited atoms moving out of the foil with a definite velocity is analyzed using interference filters and a cooled photomultiplier. Intensities of the H_α, H_β, and H_γ lines are measured as functions of the distance from the foil. The data are analyzed with a computer program, which yields (in agreement with theory) mean lives of the hydrogen-atom excited states involved and the relative initial-state populations of states belonging to the same principal quantum number. There is no indication of cascading. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstract 59355.

58723 CROSS SECTIONS FOR SINGLE-QUANTUM ANNIHILATION OF LOW-ENERGY POSITRONS IN IODINE. Friedrich, Hans (Univ., Goettingen, Ger.). Z. Phys.; 246: No. 5, 407-17 (1971). (In German).

Positrons of 200 keV were focused on a slice of NaI. This acted as a scintillation spectrometer and measured the energy loss of the positrons before annihilation. Single quanta, produced with a probability of only 2.6×10^{-5}, were registered by a second NaI detector. Two-parameter analysis of the coincidences between these two detectors allowed the determination of six cross sections for single-quantum annihilation between positron energies of 80 and 180 keV. The cross section at 180 keV was 0.09 barn per iodine atom and decreased with decreasing positron energy due to the Coulombic repulsion. Quantitative agreement was obtained with theoretical calculations within the limits of error. (auth)

58724 CASCADE PROCESS IN MESIC ATOMS. Atarashi, Masaru; Narumi, Hajime (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 6, 1779-85(Jun 1971).

In response to the recent precise measurement of mesic x-ray yields, it became possible to discuss the cascade process in mesic atom more exactly. It is shown for the muonic atom of ^{12}C that the statistical distribution of the initial mesic bound states is more reasonable than the modified one earlier obtained by Eisenberg and Kessler. On the basis of this consideration, mesic cascade processes, including strong absorption as well as natural decay, are fully analyzed and typical calculations are carried out for pionic ^9Be, ^{12}C, and ^{16}O. The results are in good agreement with recent experimental ones. (auth)

58725 POSITRON PROCESSES IN HYDROGEN, HELIUM, ARGON, AND NEON GAS. Canter, Karl Frederick. Detroit, Wayne State Univ. (1970). 104p. University Microfilms Order No. 71-17,242.

Thesis.

The time dependence of positron annihilation in hydrogen, helium, argon, and neon gas was measured at various densities and temperatures. The lifetime spectra were obtained with conventional coincidence circuitry. A variable-temperature cryostat was employed to obtain data from 4.6 to 300°K. It is found that the lifetimes of ortho-positronium in helium gas are in good agreement with those predicted by the cavity model, when a scattering length of 0.77 ± 0.04 Å is used. It is also found that the cavity model, as presented, loses its validity for small cavity radii (less than 9 Å). The lifetime spectra of positrons that do not form positronium (low-energy positrons) are observed to exhibit unusual behavior with respect to changes in density and temperature for helium and argon gas. This behavior is interpreted as resulting from the low-energy positrons being trapped in the gas after slowing down, via elastic collisions with the gas atoms, to an energy, E_r. The trapping of the positron allows a high-density electrostricted cluster of atoms to form about the positron; this results in a much larger decay rate of the positron than that observed at high temperatures for unlocalized positrons. The following estimates of E_r are deduced from the data: for helium, $E_r = 1.3 \times 10^{-3}$ to 10^{-2} eV; for argon, $E_r = 0.5$ to 2.6 eV. No evidence for the trapping of low-energy positrons in neon gas could be found. (Diss. Abstr. Int., B)

Collision Phenomena

Refer also to abstract 59671.

58726 ABSOLUTE CROSS SECTION FOR ELECTRON IMPACT EXCITATION OF 3914-A N_2^+. McConkey, J. W. (Univ.

of Windsor, Ont.); Woolsey, J. M.; Burns, D. J. Planet. Space Sci.; 19: No. 9, 1192(Sep 1971).

In a recent paper Borst and Zipf (1970) have pointed out that the excitation function reported by McConkey et al. (NSA 22: 17423) displayed anomalous threshold behavior in that the cross section displayed in a figure of that paper appeared to have a nonzero value at threshold. This was due to a drawing error. In view of the interest in this cross section it was felt worthwhile to present the low-energy data of McConkey et al. in some detail. These data are presented in tabular form and were corrected for the overlapping second positive and first negative bands. The energy scale was adjusted so that the appearance potential of the band is the spectroscopic value. (auth)

58727 COLLINEAR COLLISIONS OF AN ATOM AND A MORSE OSCILLATOR: AN APPROXIMATE SEMICLASSICAL APPROACH. **Morse, Robert I.; LaBrecque, Rodney J. (Clark Univ., Worcester, Mass.). J. Chem. Phys.; 55: No. 4, 1522-30 (15 Aug 1971).**

The semiclassical treatment by Heidrich, Wilson, and Rapp of atom–harmonic–oscillator collinear collisions with exponential and Morse repulsive potentials is extended to include collisions, with the same potentials, between an atom and a Morse oscillator. The classical equations of motion for the Morse oscillator system lead to a differential equation that can be solved in the same form as the harmonic oscillator system by an iterative method. It is found that for vibrational transitions between low-lying levels and for relative translational energies on the order of several oscillator quanta only one or two iterations are necessary for convergence to within a few percent. The results are compared with a calculation for harmonic oscillator systems. (auth)

58728 DISSOCIATIVE EXCITATION OF VACUUM ULTRAVIOLET EMISSION FEATURES BY ELECTRON IMPACT ON MOLECULAR GASES. I. H_2 AND O_2. **Mumma, M. J.; Zipf, E. C. (Univ. of Pittsburgh). J. Chem. Phys.; 55: No. 4, 1661-9(15 Aug 1971).**

The H I ($2p^1\ {}^2P \rightarrow 1s^1\ {}^2S$) 1215.67-Å Lyman-alpha line and the O I ($3s^1\ {}^3S^0 \rightarrow 2p^4\ {}^3P$) 1302.17-, 1304.87-, 1306.04-Å multiplet were excited by electrons impacting on H_2 and O_2, respectively. Their excitation cross sections were measured over the energy range from threshold to 350 eV. The cross section for dissociative excitation of Lyman-alpha has a peak value of 1.23×10^{-17} $cm^2 \pm 11\%$, and the cross section for the O I 1300-Å multiplet has a maximum value of 3.8×10^{-18} $cm^2 \pm 17\%$. The cross section for dissociative excitation of the O I ($3s^1\ {}^1P^0 \rightarrow 2p^4\ {}^1S$) 1217.6-Å line is 1.5×10^{-19} $cm^2 \pm 24\%$ at 100 eV. (auth)

58729 LYMAN-ALPHA EMISSION INDUCED BY THE COLLISIONS OF ELECTRONS WITH MOLECULAR HYDROGEN. **Kauppila, W. E.; Teubner, P. J. O.; Fite, W. L.; Girnius, R. J. (Univ. of Pittsburgh). J. Chem. Phys.; 55: No. 4, 1670-2(15 Aug 1971).**

The ratio of electron-impact cross sections of atomic and molecular hydrogen for production of uv radiation detected by an oxygen-filtered iodine-vapor-filled photon counter was precisely measured in a modulated-beam experiment. Using a filter 1.67 cm long with an oxygen pressure of 1 atm, the ratio of cross sections at 100 eV was found to be 4.05 ± 0.07. Using the known cross section for production of Lyman-alpha radiation from the hydrogen atom, the cross section for molecular radiation received by the detector was determined to be $1.48\ (\pm 0.05) \times 10^{-17}$ cm^2. (auth)

58730 SPURIOUS DISSOCIATIVE ATTACHMENT PEAKS FROM INELASTIC LOSS REACTIONS. **Chantry, P. J. (Westinghouse Research Labs., Pittsburgh). J. Chem. Phys.; 55: No. 4, 1851-60(15 Aug 1971).**

Peaks in the electron energy dependence of negative-ion production are usually the direct result of dissociative attachment reactions of the type $e + XY \rightarrow XY^{*-} \rightarrow X^- + Y$. Each such peak is related to a particular intermediate molecular negative ion state XY^{*-} and provides an approximate estimate of the energy of that state in the Frank–Condon region. A dissociative attachment peak may, however, be accompanied by a smaller "partner" peak at a higher electron energy at which an inelastic energy-loss collision leaves the electron with an energy at which subsequent dissociative attachment can occur. Thus the separation of the partner peak from the main dissociative attachment peak equals the most probable energy loss. A peak in the production of O^- from O_2 at 15 eV, observed previously but not satisfactorily explained, was studied experimentally and is shown to arise from the above-described reaction sequence involving the loss of ~8.4-eV energy by excitation of the B ${}^3\Sigma_u^-$ dissociation continuum. Satisfactory correlation of the observations with published energy-loss spectra is demonstrated, and the expected quadratic pressure dependence of the signal is confirmed. In addition a technique is described whereby the energy of the electrons directly responsible for the ion production is measured even though it differs from that of the primary electron beam. On the basis of the present observations it is concluded that in the region of 15 eV essentially all of the energy loss occurs through the 8.4-eV process, and the inelastic cross sections of Hake and Phelps are appropriately reapportioned. Peaks in the production of O^- from N_2O in the region 7- to 15-eV beam energy are shown to have a quadratic pressure dependence and are ascribed to the same general mechanism. Correlations with known energy losses are, however, less satisfactory than in the O_2 case. Possible reasons for this are suggested. Peaks in O^- production from CO at 16 and 18.3 eV arise from excitation of the A ${}^3\pi$ and A ${}^1\pi$ states. The relative magnitudes of these two excitation cross sections apparently change dramatically with increasing electron energy. Two peaks in O^- production from NO, at 14.2 and 15 eV, are similarly correlated with known energy losses and the first of these peaks is ascribed to excitation of the $c^2\pi$ and/or the $D^2\Sigma^+$ state. (auth)

58731 TEMPERATURE DEPENDENCE FOR THE DESTRUCTION OF METASTABLE He(2^3S) ATOMS. **LoDato, Vincent A.; Katsuura, Kanji (Univ. of Notre Dame, Ind.). J. Chem. Phys.; 55: No. 4, 1999(15 Aug 1971).**

Total cross sections for the reaction $He(2^3S) + He(2^3S) \rightarrow He(1S) + He^+ + e$ are reported as a function of temperature from 5 to 300°K. It is found that the total cross section increases as the temperature decreases and that there is a relatively small change (8.5×10^{-16} cm^2) between 77 and 300°K. (A.G.W.)

58732 SELECTION RULE FOR $\Sigma^+ \rightleftharpoons \Sigma^-$ TRANSITIONS IN ELECTRON–MOLECULE COLLISIONS. Cartwright, D. C. (Aerospace Corp., Los Angeles); Trajmar, S.; Williams, W.; Huestis, D. L. Phys. Rev. Lett.; 27: No. 11, 704-7(13 Sep 1971).

The differential cross section for the electron-impact excitation of the b ${}^1\Sigma_g^+$ state from the ground state of O_2 is found to decrease rapidly as the scattering angle approaches zero. This behavior is the diatomic-molecule analog of "parity-unfavored" transitions in electron–atom scattering. A group-theoretic argument is given, which explains the observations and provides a selection rule for $\Sigma^+ \rightleftharpoons \Sigma^-$ transitions in diatomic molecules. (auth)

58733 INTERPRETATION OF THE ENERGY SPECTRUM OF ELECTRONS PRODUCED IN ATOMIC COLLISIONS. **Gordeev, Yu. S.; Ogurtsov, G. N. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksp. Teor. Fiz.; 60: No. 6, 2051-9(Jun 1971). (In Russian).**

The effect of atomic-collision kinematics on the character of the emitted electron spectrum is studied. It is shown that Doppler line shift and broadening in the spectrum of electrons produced in inelastic processes involving considerable scattering of the atomic particles noticeably distort the shape of the spectrum. The position and width of the spectral lines depend not only on the energy and lifetime of the autoionization levels but also on the energy and scattering angle distribution of the colliding particles. The energy spectrum of electrons related to excitation of autoionization states of argon and helium in Ar^+–Ar and He^+–He collisions is calculated. The results of the calculation are qualitatively in good agreement with the available experimental data. (auth)

58734 ORBITAL QUANTUM NUMBER DISTRIBUTION OF HIGHLY EXCITED ATOMS PRODUCED IN COLLISIONS BETWEEN HEAVY PARTICLES. **Vinogradov, A. V.; Urnov, A. M.; Shevel'ko, V. P. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 6, 2060-5(Jun 1971). (In Russian).**

Collisions between fast protons or atoms and various atomic targets involving formation of highly excited hydrogen atoms H(nl), $n \gg 1$, are considered. The dependence of the charge-exchange and excitation cross sections on orbital momentum l is derived. As expected, hydrogen atoms are produced with greatest probability in states with l = 0, 1. Numerical calculations carried out for collisions with argon atoms show that the formulas derived in the present paper are valid for principal quantum number values as low as $n \gtrsim 3$. (auth)

58735 STUDY OF COLLISIONS BETWEEN LOW-ENERGY N^+ AND N_2: REACTION CROSS SECTIONS, ISOTOPIC COMPOSITIONS, AND KINETIC ENERGIES OF THE PRODUCTS. **Maier II, William B. (Los Alamos Scientific Lab., N. Mex.); Murad, Edmond. J. Chem. Phys.; 55: No. 5, 2307-16(1 Sep 1971).**

Reactive collisions between N^+ and N_2 were studied, and cross sections for the production of N_2^+ were measured for initial kinetic energies, $E_{c.m.}$, in the center-of-mass system between 1 and 70

XUM

eV. The kinetic energies of the product N_2^+ were determined. Isotopically labeled reactants were used, and the cross sections for producing N_2^+ containing different combinations of isotopes were measured. The reaction (1) $N^+ + N_2 \rightarrow N_2^+ + N$ is found to proceed by both atom and electron transfer. For $E_{c.m.} \lesssim 11$ eV, the cross sections for electron and atom transfer are roughly equal, but at higher $E_{c.m.}$ the atom-transfer cross section is considerably smaller than the electron-transfer cross section. The kinetic energy −Q transferred into internal energy of the products is considerably larger than the minimum required for Reaction (1) to proceed. For the electron-transfer process, the values determined for −Q are between 3 and 9.8 eV. The values of −Q found for the processes associated with atom transfer are between 3 and 50 eV. For $E_{c.m.} \gtrsim 24$ eV, it appears that a free electron may be produced by $N^+ + N_2 \rightarrow N_2^+ + N^+ + e$. A model for the reactions occurring in collisions between N^+ and N_2 is developed and shown to be in qualitative agreement with the observations. (auth)

58736 DETERMINATION OF THE K–LL AUGER SPECTRA OF N_2, O_2, CO, NO, H_2O, AND CO_2. Moddeman, W. E. (Oak Ridge National Lab., Tenn.); Carlson, Thomas A.; Krause, Manfred O.; (and others). J. Chem. Phys.; 55: No. 5, 2317-36 (1 Sep 1971).

A double-focusing electrostatic electron spectrometer was used to measure the K–LL Auger spectra resulting from electron impact for each of the elements in the gaseous molecules N_2, O_2, CO, NO, H_2O, and CO_2. An energy resolution of 0.09% full width half-maximum was normally employed. A method for analyzing these complex spectra is described. It involves the identification of normal and satellite lines. The former are defined as arising from single electron ionization from the K shell without additional excitation followed by an Auger process in which one electron fills the vacancy while a second goes into the continuum, and where all the other electrons remain in their same orbitals. Satellite lines result when extra excitation occurs either in the initial formation of the K vacancy or in the subsequent Auger process. To aid in the identification of these satellite lines, auxiliary experiments have been performed such as the study of discrete energy losses in photoionization due to electron shake-up and the comparison of Auger spectra produced by monoenergetic x rays. As a consequence of the analyses of the Auger spectra, information has been obtained on (1) the nature of initial excitation processes such as the transition of a K electron into excited discrete states and monopole excitation and (2) the identification of the energy and nature of the ground and excited states of the doubly charged molecular ions. The second ionization potential was obtained for each of the molecules, and in one case, N_2, the third ionization potential was estimated. Finally, the possible use of high-resolution electron spectroscopy in molecular as well as elemental analysis is discussed briefly. (auth)

58737 SIMPLE ESTIMATE OF TURNING-POINT ERROR IN MATRIX ELEMENTS INVOLVING JWKB WAVE FUNCTIONS. Riley, Merle E. (Sandia Labs., Albuquerque, N. Mex.). J. Chem. Phys.; 55: No. 5, 2606-7(1 Sep 1971).

A simple method for estimating the turning-point contribution to the error in certain JWKB matrix elements is described briefly. The method can be used either as an after-the-fact estimate of the error in a given element or to determine if JWKB functions should be considered. (A.G.W.)

58738 NEW SEMI-EMPIRICAL FORMULA FOR IONIZATION CROSS SECTION OF NEUTRAL ATOMS BY ELECTRON IMPACT. Tripathi, D. N.; Rai, D. K. (Banaras Hindu Univ.). Indian J. Pure Appl. Phys.; 8: No. 12, 843-4(Dec 1970).

A semi-empirical formula was developed for the calculation of cross sections for ionization of neutral atoms by electron impact from the data on incident energy. The formula involves three adjustable parameters, and calculations of ionization cross sections were made for helium and cesium atoms in their ground states. The agreement between the calculated and experimental values is especially good in the case of cesium in the higher incident-energy range and for helium over the entire energy range. (auth)

58739 PHYSICS OF IONIZED GASES. Proceedings of the International Summer School, Hercegnovi, Yugoslavia, July 6–16, 1970. Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970). 733p. (CONF-700706).

Thirty-one lectures were presented in the following fields: atomic collision processes, particle interactions with solids, and phenomena in plasmas. Separate abstracts have been prepared for all the lectures except three, which were previously abstracted as NSA 25: 3061, 3075, and 5094. (D.L.C.)

For abstracts of individual papers see: 58412, 58413, 58691–58693, 58740–58747, 58994–58998, 59005, 59006, 59098–59100, and 59165–59169.

58740 EXCITATION AND IONIZATION OF ATOMS BY ELECTRON AND PROTON IMPACT: APPROXIMATE EXPRESSIONS AND SCALING RELATIONS FOR THE CROSS SECTIONS. Drukarev, G. F. (Leningrad State Univ.). pp 1-25 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Two sources of approximate analytical expressions and scaling relations for ionization and excitation cross sections are considered: (1) the Born approximation and its various modifications and (2) classical calculations of the cross section for energy transfer from the projectile to the target electron. These expressions are used for construction of semi-empirical and interpolation formulas that reproduce the real cross sections within a factor of 1.5 to 2. (A.G.W.)

58741 EXCITATION AND IONIZATION BY ELECTRONS. Zapesochni, I. P. (Uzhgorod State Univ., USSR). pp 26-53 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Experimental methods for study of excitation and ionization by electrons are reviewed briefly. Results of studies of excitation of He, Hg, and the alkali metals and ionization of the alkali metals are summarized. 33 references. (A.G.W.)

58742 ELECTRON CAPTURE AND LOSS PROCESSES FOR HYDROGEN ATOMS, PROTONS, AND NEGATIVE IONS IN ATOMIC AND MOLECULAR GASES: EXPERIMENTAL DATA ON CROSS SECTIONS. Fedorenko, N. V. (Ioffe Inst. of Physics and Tech., Leningrad). pp 54-78 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Experimental data on cross sections for electron-loss processes of hydrogen atoms and negative ions (01, $\bar{1}1$, $\bar{1}0$) in gases and cross sections for electron capture by hydrogen atoms and protons (10, $1\bar{1}$, $0\bar{1}$) are surveyed. The experimental data on cross sections relative to the energy of primary particles are presented in diagrams, separately for all processes mentioned. The summary is given for all the energy ranges used in the cross section measurements published in the open literature, involving energies from a few tens of electron volts up to 20 MeV. The experimental data are considered on the basis of existing predictions for inelastic atomic collisions. The correct interpretation of results obtained by both magnetic mass analysis and condenser methods is discussed. 70 references. (auth)

58743 INVESTIGATION OF THE ELEMENTARY ATOMIC COLLISION PROCESSES WITH CHANGE IN CHARGE STATES BY MEANS OF COINCIDENCE METHOD. Afrosimov, V. V. (Ioffe Inst. of Physics and Tech., Leningrad). pp 79-112 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Investigations of elementary atomic collision processes in which a simultaneous analysis of the charge state of both interacting particles is applied are reviewed. A coincidence method for measuring charge-exchange cross sections is described. To illustrate the use of this method, results are given for collisions of protons and hydrogen atoms with inert gas atoms and hydrogen molecules. (auth)

58744 EXPERIMENTAL POSSIBILITIES OF THE MERGING BEAM TECHNIQUE TO STUDY ION–ATOM COLLISION PROCESSES. Belyaev, V. A. (Inst. of Atomic Energy, Moscow). pp 133-49 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Experimental possibilities of the merging-beams method are discussed in comparison with the conventional methods used for studying ion–atom collision processes. The basic principles of the merging-beams method are presented. (auth)

58745 THRESHOLD LAWS FOR ELECTRON–ATOM COLLISIONS. Grujic, P. (Inst. of Physics, Belgrade). pp 150-74 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Classical and quantum mechanical approaches to the processes of ionization and excitation in electron–atom collisions at near-threshold energies are reviewed. These theoretical results are then compared with various experimental results. 37 references. (A.G.W.)

58746 TRANSITIONS TO THE SUBLEVELS OF THE FINE AND HYPERFINE STRUCTURE IN THE SLOW HEAVY-PARTICLE-ATOMIC COLLISIONS. Chibisov, M. I. (Inst. of Atomic Energy, Moscow). pp 175-80 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

A method is presented for representing slow atomic collision processes in which a change of either the direction or the magnitude of momentum of the atomic electron occurs. Three specific cases are considered: (1) depolarization of a P-state atom (with zero spin) caused by slow collision with a heavy charged particle; (2) resonant depolarization and excitation transfer processes in collisions of two atoms; and (3) relaxation of the 2s hydrogen atom in collision with a proton. (A.G.W.)

58747 SIGNIFICANCE OF THE ENERGY RESOLUTION IN THE EXPERIMENTAL STUDY OF THE ELECTRON–ATOM AND ELECTRON–MOLECULE COLLISIONS. Stamatovic, A. (Inst. of Physics, Belgrade). pp 181-9 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

The importance of energy resolution in experimental studies is illustrated by two examples; results obtained by different investigators under the same conditions except for differences in the width of the electron energy spread are shown for energy losses of 25-keV electrons in argon and for electron attachment to SF_6. Three methods for formation of electron beams with narrow energy spread are reviewed briefly: the 127° sector of a cylindrical electrostatic condenser, the hemispherical electrostatic condenser, and the retarding-potential-difference method. 41 references. (A.G.W.)

58748 NEW VALUES FOR THE PARTIAL-WAVE ELECTRON SCATTERING FACTOR FOR THE ELEMENTS $1 \leq Z \leq 57$ AND $72 \leq Z \leq 90$ FOR INCIDENT ELECTRON ENERGIES OF 10, 40, 70, AND 100 keV. Schafer, L. (Univ. of Arkansas, Fayetteville); Yates, A. C.; Bonham, R. A. J. Chem. Phys.; 55: No. 6, 3055-6 (15 Sep 1971).

Improved numerical techniques for obtaining the partial-wave phase shifts and an improved description of the static potential field for the neutral atoms were used to calculate electron scattering factors. The results are not included here but are presented in document number NAPS-01419, which may be obtained from the Library of Congress. (A.G.W.)

58749 ELECTRONIC EXCITATION IN FAST COLLISIONS OF Na WITH SO_2 AND NO_2. LeBreton, P. R.; Mecklenbrauck, W.; Schultz, A.; Schlier, Ch. (Univ., Freibug i. B.). J. Chem. Phys.; 55: No. 6, 2940-4(15 Sep 1971).

A sputtered Na beam was used to investigate collisionally induced electronic excitation in scattering with SO_2 and NO_2. Light from the radiative decay of excited electronic states was observed at several wavelengths, and measurements were made of the excitation cross sections as a function of the center-of-mass collision energy in the range 1 to 30 eV. In both scattering systems, the most intense light measured originated from the Na ($3^2P \rightarrow 3^2S$) D line. Light from the ($4^2D \rightarrow 3^2P$) Na transition was observed, but its intensity was more than an order of magnitude smaller than that of the D line. Emission also occurred from transitions with long radiative lifetimes (~40 μsec). This emission is probably due to the $B_1 \rightarrow A_1$ molecular transitions of SO_2 and NO_2. The results are discussed in terms of a potential curve-crossing mechanism, which seems to satisfactorily explain collisionally induced alkali-atom excitation. For the molecular emission, an alternate mechanism is considered which involves vibrational coupling of the A_1 and B_1 states. (auth)

58750 IONIZATION OF LONG-LIVED HIGHLY EXCITED ATOMS BY COLLISION WITH MOLECULES. Matsuzawa, Michio (Univ. of Electro-Communications, Tokyo). J. Chem. Phys.; 55: No. 6, 2685-9(15 Sep 1971).

For the ionization of long-lived highly excited atom A^{**} by collision with molecule B, $A^{**} + B \rightarrow A^+ + B + e$, a mechanism is proposed in which an electron in the long-lived highly excited atom is ionized as a result of its energy gain from the molecule by rotational de-excitation. The cross sections at thermal velocities are calculated to be of the order of 10^{-13} cm^2 for polar molecules according to the proposed mechanism. This result is in reasonable agreement with experimental data. (auth)

58751 REACTIONS BETWEEN N_2^+ AND N_2^*. Maier II, William B. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys.; 55: No. 6, 2699-2707(15 Sep 1971).

Apparent cross sections for the reactions $N_2^+ + N_2 \rightarrow N^+ + N + N_2$ and $N_2^+ + N_2 \rightarrow N_3^+ + N$ were measured for laboratory kinetic energies E of N_2^+ between 1 and 45 eV. The primary ions are produced by electron bombardment and mass-analyzed prior to reaction. The bombarding electron energy is varied from 19 to 90 eV, and the effects of excited long-lived states of N_2^+ on the reactions are studied. Both reactions proceed when N_2^+ is in long-lived excited states and when N_2^+ is in the $X\,^2\Sigma_g^+$ and/or $A\,^2\Pi_u$ states. When $E \lesssim 15$ eV, Reaction (1) proceeds primarily from long-lived states of N_2^+ about 8.5 ± 1.5 eV above the ground state. There may be several long-lived excited N_2^+ states involved in the production of N^+ and N_3^+ at low E, and some or all of these states may be involved in long-lived emissions previously observed. A survey of the available information on N_2^+ suggests that detailed comparisons with theory will be seriously hampered by uncertainties in the production and lifetimes of the various states of N_2^+. (auth)

58752 DOPPLER BROADENING IN BEAM EXPERIMENTS. Chantry, P. J. (Westinghouse Research Labs., Pittsburgh). J. Chem. Phys.; 55: No. 6, 2746-59(15 Sep 1971).

The distribution in center-of-mass (cm) energy caused by the thermal motion of the target gas molecules has been rigorously derived for the case of a monoenergetic particle beam interacting with target molecules having an isotropic Maxwellian velocity corresponding to temperature T°K. Provided the nominal cm energy E_0 exceeds a few kT, the distribution has a full width at half-maximum (fwhm) of $W_{1/2} = (11.1\gamma kT\,E_0)^{1/2}$, where $\gamma = m/(m + M)$, m and M being the projectile and target masses. This is identical to the width derived previously in a one-dimensional approximate treatment by Bethe and Placzek. The exact and approximate distributions differ significantly, however, in shape and mean energy, particularly at low values of $E_0/\gamma kT$. The Doppler width, $W_{1/2}$, is shown to significantly affect the appearance curve of the products of endothermic reactions involving heavy particles. Convolution integrals are derived for a number of idealized forms of the cross section for such reactions. In the extreme case of a step-function cross section the estimation of the threshold E_T by the usual linear extrapolation technique gives a value that is too low by approximately $0.6W_{1/2}(E_T)$, where $W_{1/2}(E_T)$ is the fwhm evaluated at $E_0 = E_T$. The effect of the thermal velocities of the parent molecules from which the primary beam is formed is considered in the case of an accelerated beam with no kinetic energy imparted to the beam particles by the formation process and in the case where the energy of the interacting particles is controlled only by the kinetic energy released in a resonant dissociative formation process. The latter situation is shown to be described exactly by the equations derived for the monoenergetic beam case provided an appropriately defined equivalent temperature is used in place of the true temperature of the target gas. The results of the present theory are applied to the experimental data of Berkowitz, Chupka, and Gutman on the reactions $I^- + O_2 \rightarrow O_2^- + I$ and $I^- + NO \rightarrow NO^- + I$. In addition data on the reaction $O^- + O_2 \rightarrow O_2^- + O$ are presented and analyzed. The derived thresholds are consistent with $A(O_2) \geq 0.56 \pm 0.10$ eV, $A(NO) \geq 0.06 \pm 0.1$ eV, and $A(O_2) \geq 0.50 \pm 0.1$ eV, respectively. The experimental data of Maier on the reaction $C^+ + D_2 \rightarrow CD^+ + D$ are found to be consistent with a cross section that rises from threshold with approximately twice the slope of the cross section computed by Truhlar from statistical phase space theory. (auth)

58753 ION-IMPACT ENERGY-LOSS SPECTRUM OF OXYGEN. Moore, John H. Jr. (Univ. of Maryland, College Park). J. Chem. Phys.; 55: No. 6, 2760-4(15 Sep 1971).

Electronic transitions in the oxygen molecule arising from ion–molecule collisions were studied by measuring the kinetic energy lost by 100-eV to 4-keV H^+, H_2^+, and He^+ inelastically scattered from O_2. The 7- to 9-eV region of the energy-loss spectrum is strongly collision-energy dependent. The broad feature ordinarily identified as the Schumann–Runge continuum appears to be the result of at least two different transitions. A peak corresponding to the optically forbidden Herzberg continuum ($A\,^3\Sigma_u^+ \leftarrow X\,^3\Sigma_g^-$) is observed in all of the ion-impact spectra. Triplet–singlet transitions into the $a\,^1\Delta_g$ and $b\,^1\Sigma_g^+$ states are the most intense features of the H_2^+- and He^+-impact spectra. Cross sections for the above-mentioned processes exceed 10^{-17} cm^2. (auth)

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58754 MULTIPLE IONIZATION OF Ar BY 10-keV ELECTRONS AS A FUNCTION OF THE ENERGY LOSS. Van der Wiel, M. J.; Wiebes, G. (FOM-Instituut voor Atom- en Molecuulfysica, Amsterdam). Physica; 53: No. 2, 225-55(28 May 1971).

The small-angle inelastic scattering of 10-keV electrons in Ar was investigated in coincidence with the multiple ions formed. The range of energy losses —up to 400 eV —covers most processes of interest in both the M and the L shell. This study provides the general shape of the atomic oscillator-strength distributions for formation of the charge states one to four. By application of one of the sum rules for oscillator strengths, the results are found to be consistent with previous work on the impact-energy dependence of total ionization cross sections. A comparison is made with complementary information on multiple processes obtained from photoionization experiments and Auger electron spectroscopy. The evidence on shake-off transitions, occurring both in the initial excitation of the inner shell by the projectile electron and in the subsequent decay, is discussed. Furthermore, the measurements show that at energies between 40 and 80 eV a significant contribution to the double ionization in the M shell arises from doubly excited resonance states ($3s^1 3p^5 nl\ n'l'$) and from Ar^{2+}-excited continua ($3s^2 3p^3 nl$). (auth)

58755 GENERALIZED VARIATIONAL BOUNDS ON THE POSITRON-HYDROGEN REACTION MATRIX. Dirks, Johan Francis. Storrs, Conn.; Univ. of Connecticut (1970). 88p. University Microfilms Order No. 71-15,976.

Thesis.

The theory of generalized variational bounds is applied to the two-channel collisions of positrons with hydrogen leading to positronium formation. The formalism is developed in detail for this problem, and the zero-partial-wave solution is obtained in the coupled-static approximation. The nonlocal coupling kernels and the behavior of the wave functions are exhibited in detail. Eigenphase shifts and coupling parameters and the stripping and pickup cross sections as well as the elastic amplitudes for positron–hydrogen and positronium–proton collisions are studied as functions of scattering energies. A useful iteration procedure for solving the coupled equations with large coupling kernels is developed. Also, for the zero total partial wave, a reasonably complete treatment of this scattering system is presented, including a detailed discussion of the energy spectrum of the closed-channel Hamiltonian M. The coupling of the open channels to the closed channels gives rise to the effective interaction potentials, and these distortion terms are estimated variationally using the bound property of M. The orthogonality of M to the open-channel space is maintained by the presence of the energy-shift operator S, and the role of S is demonstrated in detail numerically, which produces essential cancellation of various terms. Partly because of the crudity of the trial functions used, resonance states below the first excitation threshold could not be found. Bounds on the diagonal K-matrix elements and eigenphase shifts are presented. (Diss. Abstr. Int., B)

58756 EXPERIMENTAL STUDY OF THE EFFECT OF VELOCITY AND OUTER-SHELL CONFIGURATION ON THE PROBABILITY FOR PRODUCING K VACANCIES IN VIOLENT ION–ATOM COLLISIONS AT keV ENERGIES. Fastrup, B.; Hermann, G.; Kessel, Q. C. (Univ. of Aarhus, Denmark). Phys. Rev. Lett.; 27: No. 12, 771-3(20 Sep 1971).

The probability for producing K vacancies in violent ion–atom collisions was found to depend not only on the impact parameter but also on the impact velocity and the number of vacancies in the atomic 2p subshells of the particles prior to the collision. This indicates that the K-electron promotion mechanism is different from the $L_{2,3}$-promotion mechanism determined for Z_1–Ar collisions. The K vacancies are almost exclusively produced in the lower-Z collision partner. (auth)

58757 VELOCITY CORRECTIONS FOR TOTAL SCATTERING CROSS SECTIONS. Lang, Neil C.; Lilenfeld, H. V.; Kinsey, James L. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys.; 55: No. 7, 3114-15(1 Oct 1971).

Velocity correction factors are given for a quantity $\kappa_{eff} \equiv v_i Q_{eff}$, where Q_{eff} is an effective total scattering cross section as measured in a molecular-beam experiment, and v_i is the beam velocity. If κ_{eff} is regarded as being measured at the average relative velocity, the correction factors are all near unity and only weakly dependent upon the true velocity dependence of the cross section. (auth)

58758 DISSOCIATIVE EXCITATION OF O_2 IN THE VACUUM ULTRAVIOLET BY ELECTRON IMPACT. Ajello, Joseph M. (Univ. of Colorado, Boulder). J. Chem. Phys.; 55: No. 7, 3156-7(1 Oct 1971).

The emission cross section of the 1304-Å resonance triplet ($^3S^0 \rightarrow {}^3P$) of atomic oxygen produced by dissociative excitation of O_2 by electron impact was measured from threshold to 300 eV. The peak cross section is at 100 eV with a value of 3.00×10^{-18} cm^2. The relative emission cross section of the 1356-Å multiplet ($^5S^0 \rightarrow {}^3P$) of atomic oxygen was also determined. The peak cross section for the 1356-Å multiplet at 100 eV is at least 1.65×10^{-18} cm^2. (auth)

58759 EMISSION CROSS SECTIONS OF CO BY ELECTRON IMPACT IN THE INTERVAL 1260 TO 5000 A. I. Ajello, Joseph M. (Univ. of Colorado, Boulder). J. Chem. Phys.; 55: No. 7, 3158-68(1 Oct 1971).

Emission cross sections and band emission probabilities were measured for the fourth positive system ($A\ {}^1\Pi \rightarrow X\ {}^1\Sigma^+$) and the Cameron system ($a\ {}^3\Pi \rightarrow X\ {}^1\Sigma^+$) of CO and the first negative system ($B\ {}^2\Sigma^+ \rightarrow X\ {}^2\Sigma^+$) and the comet tail system ($A\ {}^2\Pi \rightarrow X\ {}^2\Sigma^+$) of CO^+ by electron-beam excitation of CO from threshold to 300 eV. Excitation cross sections were measured for C I, C II, and O I multiplets produced by dissociative excitation of CO. A comparison of the measured emission probabilities with theoretical values based on Franck–Condon factors for direct excitation was made. Molecular branching ratios were used to extend the optical calibration from the blackbody region to the vacuum ultraviolet. (auth)

58760 EMISSION CROSS SECTIONS OF CO_2 BY ELECTRON IMPACT IN THE INTERVAL 1260 TO 4500 A. II. Ajello, Joseph M. (Univ. of Colorado, Boulder). J. Chem. Phys.; 55: No. 7, 3169-77(1 Oct 1971).

A survey of the most prominent emission features produced by electron-impact excitation of CO_2 over the wavelength range of 1260 to 4500 Å has been completed. Emission cross sections were measured from threshold to 300 eV for the $\tilde{A}\ {}^2\Pi_u \rightarrow \tilde{X}\ {}^2\Pi_g$ and $\tilde{B}\ {}^2\Sigma_u^+ \rightarrow \tilde{X}\ {}^2\Pi_g$ electronic transitions of CO_2^+ produced by ionization excitation of CO_2. Emission cross sections were also measured for the $A\ {}^1\Pi \rightarrow X\ {}^1\Sigma^+$ electronic transition of CO and the $B\ {}^2\Sigma^+ \rightarrow X\ {}^2\Sigma^+$ electronic transition of CO^+ produced by dissociative excitation of CO_2. The vibronic intensities differed from those for electron excitation of CO. In addition, emission cross sections are presented for the $^3S^0 \rightarrow {}^3P$ 1304-Å multiplet of O I, the $^2D \rightarrow {}^2P^0$ 1335-Å multiplet of C II, and several atomic multiplets of C I produced by dissociative excitation of CO_2. The relative energy variations of the emission cross section of the $a\ {}^3\Pi \rightarrow X\ {}^1\Sigma^+$ electronic transition of CO and of the $^5S^0 \rightarrow {}^3P$ 1356-Å multiplet of O I were also measured. The processes leading to these emissions are discussed. (auth)

58761 COLLISION OF AN ATOM AND A DIATOMIC: THE ADIABATIC APPROXIMATION. Thiele, Everett; Katz, Ronnie (Johns Hopkins Univ., Baltimore). J. Chem. Phys.; 55: No. 7, 3195-3200(1 Oct 1971).

The adiabatic approximation is used to compute vibrational transition probabilities for the collision of an atom and a diatomic molecule in one dimension. The accuracy of the results is evaluated in terms of a parameter β, which is proportional to the period of the oscillator divided by the length of the collision. It is seen that, for small β, the error in adiabatic transition probabilities approaches zero and that the approximation is accurate over a physically interesting range of β. (auth)

58762 REACTION MATRIX METHOD FOR COMPUTING PROBABILITIES OF VIBRATION–TRANSLATION ENERGY TRANSFER: RANGE OF APPLICABILITY FOR THE COLLINEAR COLLISION OF AN ATOM AND A DIATOMIC. Clarke, James H.; Weare, John H.; Thiele, Everett (Johns Hopkins Univ., Baltimore). J. Chem. Phys.; 55: No. 7, 3201-5(1 Oct 1971).

Transition probabilities for the case of a collinear collision of an atom and a harmonic oscillator are computed using both the distorted-wave and K-matrix approximations. Results are shown as a function of a new parameter β, which incorporates the parameters E, m, and α of Secrest and Johnson and which is proportional to the ratio of the oscillator period divided by the collision time. Ranges of applicability for the above approximate methods are discussed in terms of β for one- and two-quanta transitions. The K-matrix approach is seen to extend the range of β for which the distorted-wave approximation maintains a given degree of accuracy for one-quantum transitions. Also the K-matrix method yields vastly improved results for two-quanta transitions which exhibit the same type of dependence on β as the one-quantum-transition probabilities. (auth)

58763 DETERMINATION OF THE ABUNDANCE OF EXCITED O^+ IONS IN BEAMS PRODUCED BY ELECTRON IMPACT ON O_2, CO_2, N_2O, NO_2, AND H_2O. Hughes, B. M.; Tiernan, T. O. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). J. Chem. Phys.; 55: No. 7, 3419-26(1 Oct 1971).

The fraction of excited ions present in O^+ ion beams produced by impact of 60-eV electrons on various oxygenated molecules was determined approximately 23 μsec after formation. The technique employed involves the measurement of apparent rate coefficients for charge-transfer reactions of O^+ to N_2 and CO at very low kinetic energies (~0.3 eV) in a tandem mass spectrometer. Under these conditions, charge transfer of $O^+(^4S)$ is endothermic and the formation of N_2^+ and CO^+ products is due solely to excited O^+ ions in the reactant beam. By normalizing the rate coefficients for the reactions of O^+ from the several sources to that for an O^+ beam for which the excited ion abundance is known, the fractional abundance of O^{+*} in each of the respective ion beams is calculated. These fractions for O^+ beams from the indicated sources were found to be: CO_2, 0.04; N_2O, 0.43; NO_2, 0.34; H_2O, 0.90. The fractional abundance data are utilized for the study of the reactions of both ground-state and excited-state O^+ with Ar and Kr. Ground-state $O^+(^4S)$ was found to be completely unreactive with Ar even at ion kinetic energies up to 170 eV. The cross section for charge transfer from excited O^+ ions to Ar is quite small at very low kinetic energies but increases sharply at energies above $E_{lab} \sim 20$ eV. Both $O^+(^4S)$ and $O^+(^2D)$ undergo charge transfer to Kr over the energy range investigated and a maximum is observed in the cross section for the $O^+(^4S)$ reaction. The results are qualitatively consistent with the adiabatic hypothesis for nonresonant charge transfer. (auth)

58764 KINETIC ENERGIES OF IONIZATION PRODUCTS FROM COLLISIONS OF Ar–Ar AND He–He BELOW 150 eV c.m. ENERGY. Hammond, R. H. (Brown Univ., Providence); Henis, J. M. S.; Greene, E. F.; Ross, John. J. Chem. Phys.; 55: No. 7, 3506-15(1 Oct 1971).

Measurements have been made of the energy spectra of ions and electrons produced in the collision of beams of neutral Ar of given energy (laboratory energy range 57 to 240 eV) with a gas of Ar and of neutral He (145 to 300 eV) with a gas of He. The energy dependence of the total cross section for ionization is consistent with previous results. The electron spectra from collisions of Ar + Ar show peaks at 0, 6, and ~9 eV. From this it is estimated that about 15% of the Ar^+ ions produced come from autoionizing states of Ar. For certain ranges of initial relative energy Ar – Ar ionization occurs mostly in backscattering collisions. An analysis of the ion spectra of experiments at these initial relative energies (greater than 33 eV), made with a simple model, shows that most ions are produced by two curve crossings 12 ± 2 eV and 22 ± 1 eV above the ionization potential (15.8 eV). (auth)

58765 DISSOCIATION OF CO_2 BY ELECTRON IMPACT WITH THE FORMATION OF METASTABLE $CO(a^3\Pi)$ AND $O(^5S)$. Freund, Robert S. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Chem. Phys.; 55: No. 7, 3569-77(1 Oct 1971).

Molecular-beam time-of-flight measurements show that CO_2 is dissociated by electron impact to give two metastable fragments, $CO(a\ ^3\Pi)$ and $O(^5S)$. The experimental dissociation limit for production of $CO\ (a\ ^3\Pi)$ lies at 11.65 ± 0.30 eV, which agrees with the 11.45-eV energy of $CO_2 \xrightarrow{e} CO(a\ ^3\Pi) + O(^3P)$. The excitation function for production of $CO(a\ ^3\Pi)$ shows structure that can be correlated with dissociation processes involving higher triplet states of CO and excited states of O. The cross section for formation of $CO(a\ ^3\Pi)$ has a maximum at 27 ± 1 eV, a magnitude 0.4 ± 0.2 times the maximum cross section for $CO \xrightarrow{e} CO(a\ ^3\Pi)$, and a value probably not far from 4×10^{-17} cm^2. (auth)

58766 GLAUBER AMPLITUDES IN CHARGED-PARTICLE–HYDROGEN-ATOM COLLISIONS. Thomas, Brian K.; Gerjuoy, E. (Univ. of Pittsburgh). J. Math. Phys. (N. Y.); 12: No. 8, 1567-76(Aug 1971).

The Glauber scattering amplitudes for the excitation of the ns and np levels of atomic hydrogen by electrons (or protons) incident upon the ground state were obtained in closed form. In contradistinction to previously quoted results, these new expressions require no numerical integration. For small n, the amplitudes reduce to simple sums of hypergeometric functions. Hence the Glauber amplitudes for these transitions now can be computed with scarcely more difficulty than the Born amplitudes. A selection rule for arbitrary transitions is derived. (auth)

58767 THEORY OF ANOMALY OF THE DIFFERENTIAL SCATTERING CROSS SECTIONS FOR HIGH-ENERGY ATOMS IN THE PRESENCE OF AN INELASTIC PROCESS. Kotova, L. P.; Ovchinnikova, M. Ya. (Inst. of Chemical Physics, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 6, 2026-39(Jun 1971). (In Russian).

The shape of the differential scattering cross sections (elastic and inelastic) for high-energy atoms is investigated in the presence of an inelastic process involving quasi intersection of terms. It is shown that oscillations of the inelastic cross section at angles exceeding the threshold value τ_{II} is due to interference of contributions from two trajectories. Parameters of the scattering functions contributing to the process and also some potential parameters can be determined on the basis of the experimental oscillation phase. It is shown that in a certain angular range ($\tau_{II}^{\gamma} < \tau < \tau_0$) the elastic cross section near the beginning of the cross-section anomalies is the result of interference of contributions of three trajectories (or three scattering-function branches); at larger values ($\tau > \tau_0$) the cross section results from interference of two scattering trajectories. Quasi-classical expressions are obtained, which are replaced by quantum expressions in the vicinity of the threshold angles τ_{II}, τ_{II}^{γ} and angle τ_0 corresponding to the term intersection radius R_0. The calculated shape of the elastic cross section, in which a certain approximation of the scattering function is employed, qualitatively agrees with the experiments and permits formulation of a prescription for determination of the term intersection radius R_0 on basis of the elastic-cross-section experimental curves. (auth)

58768 CHARGE-CHANGING CROSS SECTIONS FOR HEAVY IONS IN COMPLEX MOLECULES: THE FAILURE OF AN ADDITIVE RULE. Wittkower, A. B. (High Voltage Engineering, Burlington, Mass.); Betz, H. D. J. Phys., B (London); 4: No. 9, 1173-5(Sep 1971).

Electron-capture and -loss cross sections were measured for 12-MeV iodine ions passing through H_2, N_2, O_2, CO_2, N_2O, CH_4, and $(CH_2)_3O$. It is shown that, in contrast to recent data for fast hydrogen beams, it is not possible in this case to predict the cross sections in a complex molecular target by summing contributions from the measured cross sections of its constituent atoms. (auth) (UK)

58769 MEASUREMENT OF THE CROSS SECTIONS FOR ELECTRON-IMPACT IONIZATION OF MULTI-ELECTRON IONS. II. N^{2+} TO N^{3+} AND C^+ TO C^{2+}. Aitken, K. L.; Harrison, M. F. A.; Rundel, R. D. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., B (London); 4: No. 9, 1189-99(Sep 1971).

Absolute measurements were made of the electron-impact ionization cross sections for the reaction $N^{2+} + e \rightarrow N^{3+} + 2e$ and its isoelectronic partner $C^+ + e \rightarrow C^{2+} + 2e$. The technique of crossed beams was employed, and, at incident electron energies in excess of about 100 eV, the cross section for N^{2+} can be expressed by $Q = (567\ E)lg(E/51.0)/(10^{-17}\ cm^2)$ and that for C^+ by $Q = (1060/E)lg(E/31.5)/(10^{-17}\ cm^2)$, where E is in eV. Measurements were extended to energies below threshold and the presence of metastable ions was observed; their influence upon the measured cross sections is discussed. The present experimental data are compared with Coulomb – Born calculations by Moores, classical binary-encounter calculations by Thomas and Garcia (1969), and a semiempirical estimate by Lotz (1968). (auth)(UK)

58770 EVALUATION OF TRANSITION MATRIX ELEMENTS FOR MULTIPHOTON PROCESSES IN ATOMIC HYDROGEN. Karule, K. (Inst. of Physics, Riga). J. Phys., B (London); 4: No. 9, L67-70(Sep 1971).

A method is proposed to calculate Nth-order bound – bound and bound – free radial transition matrix elements for multiphoton processes in atomic hydrogen in the nonrelativistic dipole approximation. The analytical expressions for these transition matrix elements are derived. (auth) (UK)

58771 LOW-ENERGY ATOMIC COLLISIONS. II. FORMAL THEORY OF H^+–H COLLISIONS. Kouri, Donald J. (Univ. of Houston, Tex.); Curtiss, C. F. Mol. Phys.; 21: No. 4, 609-33 (1971).

The Schrödinger equation for the system H^+ – H developed in a previous paper (1966) is considered using new expansion functions for electronic states obtained from H_2^+ molecular ion electronic eigenfunctions by a unitary transformation. These new functions have the advantage of remaining orthonormal at all internuclear separations and asymptotically becoming symmetrized atomic hydrogen states. Although they are eigenfunctions of the H_2^+ hamiltonian only in the limit of large internuclear distance, the effect of the H_2^+ hamiltonian on these functions is readily found. Because of coupling that remains nonzero in the limit of large interproton distance, each independent formal solution of the H^+ – H equations involves more than one expansion state in this limit. These solutions may be expressed asymptotically as column vectors multiplied by incoming or outgoing spherical waves. The formal theory of scattering as developed by Gell – Mann and Goldberger has been utilized along with the projection formalism of Feshbach to obtain the correct asymptotic form of the scattering wave function. It is shown that coefficients of all outgoing spherical waves cannot be interpreted as scattering amplitudes. In addition, new interference

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phenomena are found to result from the presence of the infinite-ranged coupling. The present formalism is shown to reduce to the usual perturbed-stationary-states method in the approximation that the infinite-ranged coupling is neglected. (auth) (UK)

58772 ITERATIVE PERTURBATION SOLUTION OF THE INVERSE POTENTIAL PROBLEM. **Bottcher, C. (Harvard Coll. Observatory, Cambridge, Mass.). J. Phys., B (London): 4: No. 9, 1140-9(Sep 1971).**

A method is suggested for systematically obtaining model potentials that accurately reproduce spectroscopic or scattering data. Applications are made to atomic systems consisting of one electron outside a closed shell for the closed shells Li^+, Na^+, K^+, He, and Ne. (auth) (UK)

58773 ANGULAR DISTRIBUTION OF PRODUCTS OF REACTIONS PROCEEDING THROUGH FORMATION OF A LONG-LIVED COMPLEX. **Nikitin, E. E.; Rusin, L. Yu. (Inst. of Chemical Physics, Moscow). Dokl. Akad. Nauk SSSR; 198: No. 2, 330-2(11 May 1971). (In Russian).**

The method of crossed molecular beams may be used to study angular distribution of particles for elastic and inelastic collisions. The theoretical calculations of angular distribution present a difficult problem, requiring a large expenditure of machine time because of insufficient knowledge regarding intra- and intermolecular interactions. The problem may be simplified by limiting it to processes proceeding through the formation of complexes, the lifetimes of which are substantially greater than the period of rotation of a molecule. A statistical approximation is employed. The final result does not describe the resonance structure of scattering, but the differential cross section is equal to the sum of the potential scattering and the scattering through the complex. (K.S.W.)

58774 MEASUREMENT OF THE CROSS SECTIONS FOR ELECTRON-IMPACT IONIZATION OF MULTI-ELECTRON IONS. I. O^+ TO O^{2+} AND O^{2+} TO O^{3+}. **Aitken, K. L.; Harrison, M. F. A. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). J. Phys., B (London); 4: No. 9, 1176-88(Sep 1971).**

The technique of crossed electron–ion beams was used to make absolute measurements of the electron-impact ionization cross section for the reaction $O^+ + e \rightarrow O^{2+} + 2e$. Incident electron electron energies ranged from below threshold up to 1000 eV, and at energies above 100 eV the cross section can be expressed as $Q = (1530/E)\lg(E/55.0)(10^{-17}\ cm^2)$, where E is the electron impact energy in eV. A similar measurement for $O^{2+} + e \rightarrow O^{3+} + 2e$ up to an incident energy of 500 eV yields the expression $Q = (626/E)\lg(E/55.0)(10^{-17}\ cm^2)$. Evidence for the presence of metastable oxygen ions in the parent ion beams is presented and their influence on the measured cross sections discussed. The experimental results are compared with a Coulomb–Born calculation by Moores, a classical binary-encounter calculation by Thomas and Garcia (1969), and a semiempirical estimate by Lotz (1968). Comparison of the present measurements for O^+ with the ionization cross section of the isoelectronic nitrogen atom supports the measurements of Smith et al. (1962) for this atom. A comparison is also made between O^{2+} and its isoelectronic ion N^+. (auth) (UK)

58775 HIGH-ENERGY TREATMENT OF ATOMIC COLLISIONS. **Dettmann, Klaus (Technische Hochschule, Aachen). Springer Tracts Mod. Phys.; 58: 119-206(1971).**

The basic theory for a high-energy treatment of atomic collisions is established. Potentials and masses are not specified so that nuclear scattering is also included. A wave-packet theory for direct and rearrangement collisions is set up. In a separate chapter, this theory is applied to Coulomb scattering. The impact-parameter treatment is formulated and justified for a one-dimensional model. The leading term of the high-energy expansion for the differential and total cross sections for three-particle collisions is calculated. Calculation of the total inelastic and charge-exchange cross sections for proton–hydrogen collisions is used an as example. The Schwinger variational principle for the T-matrix of direct and rearrangement collisions is formulated. (46 references) (A.G.W.)

58776 ISOTOPE DEPENDENCE IN K, L, AND M SHELL IONIZATION CROSS SECTIONS BY $^3He^+$ AND $^4He^+$ BOMBARDMENTS. **Shima, Kunihiro (Hiroshima Inst. of Tech.); Makino, Isao; Sakisaka, Masakatsu. J. Phys. Soc. Jap.; 31: No. 4, 971-6(Oct 1971).**

The ionization cross sections of Al K, Cu L, Mo L, Ag L and W M shells are presented for the incident $^3He^+$ and $^4He^+$ ions in the energy range from 45 to 90 keV/amu. The cross sections were evaluated from the experimentally obtained thick-target yields of characteristic x rays, referring to the semiempirical stopping-power data of helium ions. Contrary to the prediction by the Born approximation, isotope dependence was clearly ascertained in the ionization of target atoms. The quantitative analysis for Al K-shell ionization has shown that the collision process can be explained by the "binding theory." The isotope dependence is mainly attributed to the Coulomb deflection difference of the isotopic projectiles near the target nucleus. (auth)

58777 IONIZATION CROSS SECTIONS OF Ca, Sr, AND Ba BY ELECTRON IMPACT. **Okuno, Yasuko (Tokyo Univ.). J. Phys. Soc. Jap.; 31: No. 4, 1189-95(Oct 1971).**

Total ionization cross sections of Ca, Sr, and Ba by electron impact were measured by the crossed-beam technique. The intensity of the neutral atomic beam is determined by the deposition method. Sample atoms deposited onto a beam collector are quantitatively analyzed by atomic absorption spectrophotometry. The absolute cross sections are determined to be 6.2 ± 0.2 Å^2 at 13.6 eV for Ca and 7.2 ± 0.3 Å^2 at 12.6 eV for Sr. The absolute cross section of Ba could not be determined because of poor sensitivity of the spectrophotometer for Ba. Possible systematic errors are estimated to be between +8% and −19% for both Ca and Sr. Relative cross sections of the three elements are obtained for electron energies from 0 to 1000 eV. Each curve for the total ionization cross section as a function of electron energy has two maxima in the low-energy region, one of which is considered to be due to autoionization. The results are compared with some experimental results and theoretical calculations by other workers. (auth)

58778 DIFFERENTIAL CROSS SECTION FOR THE REACTIVE SCATTERING OF DEUTERIUM ATOMS BY HYDROGEN MOLECULES: CROSS SECTIONS FOR THE EXCITATION OF $Na(3^2P)$ BY COLLISIONS WITH INTERNALLY EXCITED MOLECULAR HYDROGEN, DEUTERIUM, AND NITROGEN. **Krause, Herbert Francis. Pittsburgh; Univ. of Pittsburgh (1970). 258p. University Microfilms Order No. 71-17,689.**

Thesis.

The reaction $D + H_2 \rightarrow HD + H$ was investigated in a modulated cross-beam experiment utilizing thermal-energy beams. The differential scattering cross section for reactively formed HD was measured and the mean velocity of detected HD was determined via phase spectrometry. These measurements indicate that reactive collisions in the vicinity of the reaction threshold are of the direct type with the HD generally preferring to be scattered in a direction anti-parallel to that of the attacking atom without significant internal excitation. For the purpose of calibrating this cross section absolutely, the differential cross section for $D + H_2 \rightarrow D + H_2$ was studied and normalized to the known total cross section. The reactive cross section was estimated to be of order 2 Å^2 by comparing differential signals of the reactive and elastic processes. The empirical results of this study are in general agreement with theoretical calculations performed by Micha and Karplus et al. In another series of experiments, the collisional excitation of $Na(3^2P)$ by H_2, D_2, and N_2 was studied using modulated thermal-energy crossed beams, and sodium D radiation was detected. In one configuration the effective excitation rate constants for these molecules were determined and these rates were studied as a function of molecular-beam temperature. In a second configuration the molecular beam was velocity-selected, and the production of $Na(3^2P)$ was observed as a function of molecular-beam velocity and temperature. Excitation cross sections determined as a function of initial molecular vibrational state for translational and vibrational temperatures of order 1500°K and 3000°K indicate that excitation is most efficient when the electronic energy is supplied purely by molecular internal energy. The energy transfer efficiency is smaller by about one order of magnitude when molecular internal energy and the kinetic energy of collision couple to supply the energy of excitation. Effective cross sections for the inverse process derived from excitation cross sections via microscopic reversibility are in agreement with those determined in quenching studies carried out at high temperatures. Results for N_2 are in general agreement with the theory of Bauer, Fisher and Gilmore and slightly poorer agreement with the theory of Bjerre and Nikitin. (Diss. Abstr. Int., B)

58779 EXCITATION OF THE AUTO-IONIZATION LEVELS OF He BY COLLISION WITH A HEAVY PARTICLE FOR MEDIUM ENERGIES (10 TO 130 keV). **Bordenave-Montesquieu, Alain; Benoit-Cattin, Pierre (Univ., Toulouse). Compt. Rend., Ser. B; 272: No. 26, 1473-6(28 Jun 1971). (In French).**

The energy spectra of the electrons stripped from auto-ionized helium atoms by heavy (H_1^+, H_2^+, H_3^+) fast (10- to 130-keV) particles were determined. In proton–He collisions the first terms of the singlet series $2sns\,^1S$, $2pnp\,^1S$, and sp, $2n+\,^1P$ were identified; in addition the asymmetry of the $2s2p\,^1P$ peak was demonstrated. (auth) (France)

58780 POLARIZATION OF THE H_β LINE EMITTED IN $Li^+ + H_2$ COLLISIONS. Carre, M.; Desesquelles, J.; Gaillard, M. (Univ., Lyon). Compt. Rend., Ser. B; 273: No. 1, 12-14 (5 Jul 1971). (In French).

Polarization of the H_β line emitted in the dissociation of the H_2 molecule bombarded with 10- to 110-keV Li^+ ions was observed. The polarization rate measured is compatible with that obtained from the theory of Van Brunt and Zare. (auth) (France)

58781 TOTAL EFFECTIVE SCATTERING CROSS SECTIONS OF THE HD-INERT GAS SYSTEMS IN THE THERMAL ENERGY REGION. Butz, H. P.; Feltgen, R.; Pauly, H.; Vehmeyer, H.; Yealland, R. M. (Max-Planck-Institut fuer Stroemungsforschung, Goettingen, Ger.). Z. Phys.; 247: No. 1, 60-9(1971). (In German).

Total cross sections of velocity-selected HD beams scattered by the inert gases in a scattering chamber were measured in the velocity range from 300 to 3500 m/sec. No effects of the HD asymmetry are visible; the potential parameters obtained are, to within the error limits, the same as those for scattering of H_2 and D_2 by inert gases. The glory structure of all three scattering systems can be fitted relatively well using the Lennard-Jones (12,6) potential. This does not necessarily provide valid information about the actual potential shape for these systems, it can also be a result of the small "potential well capacity" parameters B of these systems, since for decreasing B values the absolute glory amplitude becomes more and more insensitive to potential shape changes, as can be seen from both semiclassical and exact calculations. (auth)

58782 TOTAL EFFECTIVE CROSS SECTIONS FOR THE SCATTERING OF He, HD, AND D_2 BY SEVERAL MOLECULES. Butz, H. P.; Feltgen, R.; Pauly, H.; Vehmeyer, H. (Max-Planck-Institut fuer Stroemungsforschung, Goettingen, Ger.). Z. Phys.; 247: No. 1, 70-83(1971). (In German).

The measured velocity dependence of the total scattering cross section for the scattering of He, HD, and D_2 by the molecules CH_4, N_2, O_2, NO, CO, HD, and D_2 can be described relatively well by a Lennard-Jones (12,6) potential. Only for the systems with a CO_2 target are large deviations from the L-J (12,6) predictions found; the measured glory amplitudes are considerably smaller. The deformation of the spherically symmetric potential that must be made in order to fit the CO_2 glory pattern is given. Furthermore, the CO_2 systems were calculated using an angle-dependent L-J (12,6) potential, taking into account only elastic processes. The agreement with the measurements is good. (auth)

Atomic Theory

Refer also to abstracts 58684, 58702, 58704, 59232, 59447, and 59538.

58783 INTERNATIONAL SYMPOSIUM ON THE THEORY OF ATOMIC STRUCTURE, GIF-SUR-YVETTE, FRANCE, 8–11 JULY 1970. J. Phys. (Paris), Colloq.; 31: No. 11-12, C.1-239(Nov-Dec 1970). (In French and English). (CONF-700718).

Twenty-one separate papers were abstracted. Symmetry and atomic structure, correlations and radial wave functions, transition probabilities, and relativistic corrections were investigated. (France)

For abstracts of individual papers see: 58684, 58696, 58697, and 58784–58801.

58784 USE OF REFLECTION SYMMETRY IN ATOMIC THEORY. Jucys, A. P. J. Phys. (Paris), Colloq.; 31: No. 11-12, C.3-7(Nov-Dec 1970). (In French).

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

The symmetry relations for the Clebsch–Gordan coefficients of the angular momentum theory and those for the matrix elements of the irreducible tensor operators containing the transpositions as well as the mirror reflections are presented. The annihilation operator of an electron was interpreted as that of creation completely reflected. This reflection consists of a mirror reflection of the coordinate system and of the space with respect to the xy plane. The seniority quantum number ν of Racah must be replaced by $\nu = 41 + 4 - \nu$ for the almost closed shell of electrons. (auth) (France)

58785 SECOND USE FOR THE GROUP G_2. Judd, B. R. (Johns Hopkins Univ., Baltimore). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.9-16(Nov-Dec 1970).

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

The group G_2, when used for f electrons, exhibits many unusual and surprising features. In an effort to understand them, the use of G_2 is studied for the p + h shell. The L structure of the irreducible representations (30) and (22) becomes apparent. Analogues are found of the celebrated null 6-j symbol associated with the existence of G_2 in the f shell. The vanishing of the matrix elements of the spin– orbit interaction between F and G states that belong to (21) is understood in terms of simple selection rules on the quasiparticle angular momenta I^h and I^p of the h and p electrons. The operators Ω and χ_2 that Racah introduced for studying the Coulomb interaction within the f shell are shown to be complementary in that they are the only two operators required to express the eigenvalues of $I^h \cdot I^p$ for (21). Properties of the p + h shell are analyzed, particularly the necessity for introducing complex phases in the quasi-particle description. (auth) (France)

58786 GROUP PROPERTIES OF RADIAL WAVE FUNCTIONS. Armstrong, L. L. (Johns Hopkins Univ., Baltimore). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.17-23(Nov-Dec 1970).

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

The noncompact group O(2,1) is used in an investigation of hydrogenic radial wave functions. These radial functions are shown to form bases for infinite dimensional representations of the algebra of O(2,1). It is found that r^N and r^{-N} (N positive) transform as tensors with respect to this algebra. Analysis of matrix elements of r^N and r^{-N} shows that the Wigner–Eckart theorem is valid for this group and that the pertinent Clebsch–Gordan coefficients are proportional to the familiar R(3) Clebsch–Gordan coefficients. This porportionality provides simple explanations of the selection rules for hydrogenic radial matrix elements noted by Pasternack and Sternheimer, and the proportionality of hydrogenic expectation values of r^N and r^{-N} to $3 - j$ symbols. (auth) (France)

58787 STUDY OF $(d + s)^n p^m$ CONFIGURATIONS USING THE SU_3 GROUP. Feneuille, S. (CNRS, Orsay, France); Crubellier, A.; Haskell, T. J. Phys. (Paris), Colloq.; 31: No. 11-12, C.25-32(Nov-Dec 1970). (In French).

From International symposium on the theory of atomic structure; Giz-sur-Yvette, France (8 Jul 1970). See CONF-700718.

A new scheme, based on SU_3 and using Elliott's results on $(d + s)^n$ configurations, is given for studying $(d + s)^n p^m$ configurations. It is shown in some particular cases that SU_3 is not really a good approximate symmetry for the considered configurations; however, this scheme is very useful for calculating matrix elements of operators generally used in atomic spectroscopy. To emphasize this point, the properties of one-particle operators concerning s, d, and p electrons are specified in this classification and a complete set of symmetrized, scalar, hermitian spin-independent two-particle operators, acting within $(d + s)^n p^m$ configurations and having well-defined symmetry properties, is constructed explicitly. (auth) (France)

58788 SYMMETRY PRINCIPLES IN ATOMIC SPECTROSCOPY. Wybourne, B. G. (Univ. of Canterbury, Christchurch, N. Z.). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.33-9(Nov-Dec 1970).

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

It is suggested that while the theory of compact groups leads to an elegant mathematical formalism for calculating the properties of many-electron systems, it does not lead to a physically significant interpretation of these properties. The desirability of applying noncompact groups to many-electron systems is discussed. As a preliminary study, the tensor operator algebra of SO(4) is developed using the known SO(4) vector coupling coefficients which in turn are used to study the canonical chain $SO(5) \supset SO(4) \supset SO(3) \supset SO(2)$ which finds a physical realization in the dynamical symmetry of the bound states of the hydrogen atom. These results are then extended to the representations of the noncompact de Sitter group SO(4,1) constructed on the canonical basis $SO(4,1) \supset SO(4) \supset SO(3) \supset SO(2)$. The possibility of applying the theory of noncompact groups to many-electron atoms is then considered. (auth) (France)

58789 REDUCED MATRIX ELEMENTS AND REPRESENTATION OF WAVE FUNCTIONS. Innes, F. R. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.43-6(Nov-Dec 1970).

From International Symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

An extension is suggested from wave function representations with a minimal set of intermediate terms, treeform or dendritic in structure, to simply polygonal or more elaborate structures,

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with a larger number of intermediates. These representations are maintained without explicit reference to axis orientation, in quasi spin, spin, and angular spaces. In the treatment of a single shell, a fermion operator, multilinear in general, must occur at each vertex of the representation. The vertex coefficients are then submatrix elements of these operators, or coefficients of fractional parentage for the appropriate structures. Here it is useful to introduce a small submatrix element for the study of the coefficients. It is also convenient to adopt an ordering of terms with the use of quasi-spin and spin weights particularly for assignment of phases. The p-shell provides a few instances of number-free parentage coefficients with properties relating to adjoint and complement. (auth) (France)

58790 S-FUNCTIONS AND SYMMETRY IN PHYSICS. Butler, P. H. (Univ. of Canterbury, Christchurch, N. Z.). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.47-50 (Nov-Dec 1970).

From International Symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

A comprehensive set of computer programs for the extensive calculation of the character theory of groups was developed. Using the algebra of S functions, it was possible to calculate Kronecker products or branching rules within the compact continuous groups U_n, O_n, R_n, Sp_n, and G_2. A straightforward systematic method of calculating outer plethysms and its use in calculating continuous group properties is discussed. The operation of the inner plethysm may be used to calculate similar properties of finite groups. The systematic evaluation of this operation by a method that does not require the use of character tables is also discussed. (auth) (France)

58791 SPATIAL EIGENFUNCTIONS OF THE SPIN-INDEPENDENT MANY-ELECTRON HAMILTONIAN. Musher, J. I. (Univ. of Yeshiva, New York). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.51-67 (Nov-Dec 1970).

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

The symmetry properties of the spatial eigenfunctions of the spin-independent many-electron Hamiltonian are examined and their eigenvalues and degeneracies are discussed along with eigenvalues of the corresponding physical wave functions. Detailed examples are given, mostly for the three-electron problem, with certain properties of the level structure of a given configuration and the ordering of such levels generalized to the many-electron problem. The use of nonsymmetric perturbation theoretic procedures for calculating the spatial eigenfunctions is discussed, and the potential utility of such procedures is considered. (auth) (France)

58792 STABILITY OF SELF-CONSISTENT SYMMETRIES IN ATOMIC THEORY. Prat, R. F. (Paris Univ., Orsay, France). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.69-70 (Nov-Dec 1970). (In French).

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

Spherical symmetry is self-consistent only in complete shells states. However, a spherical solution need not be stable unless it is an absolute minimum, although this can never be proved. A search for deformed variational solutions was undertaken; with the neon atom, spherical symmetry appears as one of the results of a Roothaan-type analytic calculation based on Bagus' set of s- and p-only Slater orbitals. (auth) (France)

58793 THEORY OF ELECTRON CORRELATION IN GROUND AND EXCITED STATES WITH APPLICATION TO ATOMIC PROPERTIES. Sinanoglu, O. (Yale Univ., New Haven). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.83-8 (Nov-Dec 1970).

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

. Various ways of introducing electron correlation into atomic structure theory are briefly examined. It is shown that the pair correlation theory of Sinanoglu et al., applies mainly to closed shells, and at best, to a few open-shell ground states. Electron correlation of both the energy and wave function of a many-electron atom in an excited state displays very different behavior; such behavior can be explained by a recent theory. A summary of the essential points in the theory of excited states is given. Applications to electron affinities, excitation energies, and transition probabilities are presented. The results obtained are compared with the most recent experimental data. (auth) (France)

58794 MANY-BODY THEORY FOR HYPERFINE EFFECTS IN ATOMS AND MOLECULES. Das, T. P.; Dutta, C. M.; Dutta, N. C. (Univ. of Utah, Salt Lake City). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.99-104 (Nov-Dec 1970).

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

Results from the application of linked-cluster many-body perturbation theory to atomic hyperfine constants are reviewed. As a specific example of the application of this procedure to molecular systems, the problem of the indirect nuclear spin–spin coupling constant of the HD molecule was studied. The complete set of states were the exact bound and continuum states of the H_2^+ molecular ion with the same internuclear separation as for the H_2 molecule. The calculated value of J_{HD} by the Fermi contact interaction mechanism is +42.57 Hz; the most recent experimental value is +42.7 ± 0.7 Hz. (auth) (France)

58795 EXTENSION OF THE HYLLERAAS EXPANSION FOR THE HELIUM GROUND STATE. Somerville, W. B. (University Coll., London). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.107-9 (Nov-Dec 1970).

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

In the work of Hylleraas, variational terms containing only integer powers of $(r_1 + r_2)$, $(r_1 - r_2)$, and r_{12} were used. H. M. Schwartz introduced half-integer exponents. The use of general real number exponents is discussed here. The first results suggest that the method could be of value. (auth) (France)

58796 THE PSEUDO-ATOM: A SOLUBLE MANY-BODY PROBLEM. Moshinsky, M.; Novaro, O.; Calles, A. (Univ. Mayor de San Andres, La Paz, Bolivia). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.125-40 (Nov-Dec 1970).

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

If relativistic effects are disregarded, an atom of more generally, an ion of charge Z can be considered as a system of n fermions of spin $\frac{1}{2}$ in an attractive Coulomb potential interacting through a repulsive Coulomb force. As this problem cannot be solved when $n > 1$, a large number of approximation techniques have been put forward. The common Coulomb potential is replaced by an attractive harmonic oscillator, and the interacting force by a repulsive harmonic oscillator. The resulting model, which can be called a pseudo-atom, can be solved exactly for any value of n. Approximation procedures based on perturbation, variation, Hartree–Fock methods, variance, density matrix, etc are then applied to the problem. The convergence of all these methods to the exact energy and wave function is discussed, first when $n = 2$ electrons, and then for closed shell-pseudo-atoms with up to 112 electrons. (auth) (France)

58797 WHY THE HARTREE–FOCK F^k INTEGRALS ARE TOO LARGE. Fred, M. (Argonne National Lab., Ill.). J. Phys. (Paris), Colloq.; 31: No. 11-12, C. 161-2 (Nov-Dec 1970).

From International symposium on the theory of atomic structure; Giv-sur-Yvette, France (8 Jul 1970). See CONF-700718.

The F^k integrals evaluated from Hartree–Fock (HF) radial eigenfunctions are usually about 50% larger than those derived experimentally, a fact ascribed to the neglect of configurational interaction and other effects in the HF calculation. As a complete theory is difficult, it is useful to consider the properties of the HF solutions more directly. Slater has discussed the nonhydrogenic relation between the eigenvalue and the size of the function: the effective Z for the function is larger than the effective Z for the energy. The ratio of $\langle 1/r \rangle$ evaluated for the two Z values reproduces the calculated/experimental F^k ratio. Hence, the functions cannot be used directly as a measure of energy; they may, however, be simply corrected. (auth) (France)

58798 EVALUATION OF EFFECTIVE OPERATORS FOR CONFIGURATION INTERACTION. Morrison, J.; Kajnak, K.; Wilson, M. (Argonne National Lab., Ill.). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.167-71 (Nov-Dec 1970).

From International Symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

Corrections to the Hartree–Fock–Slater integrals due to electrostatic configuration interaction are calculated for the $4\,f^2$ configuration of Pr IV using perturbation theory and graphical methods. The Trees parameter α, and the additional parameters β, and γ are also calculated. In the second order, the interaction with 27 bound configurations, and 8 single-particle excitations to the continuum gives $F^2 = 88\,963{,}14$, $F^4 = 61\,000.08$, $F^6 = 33\,353{,}80$. This may be compared with the empirical values $F^2 = 72\,549$, $F^4 = 53\,874$, $F^6 = 35\,973$, $\alpha = 24$, $\beta = -586$, and $\gamma = 728$. (auth) (France)

58799 RELATIVISTIC ATOMIC HAMILTONIAN. Wadzinski, H. T. (CNRS, Orsay, France). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.213-19 (Nov-Dec 1970).

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

The relativistic hamiltonian for a multi-electron atom is presented in such a way as to render explicit the assumptions and approximations made. The basic assumptions made are the validity of quantum electrodynamics, the possibility of using effective potentials to reduce the quantum electrodynamics to a hamiltonian form. Ambiguities in the potential obtained for the first-order interaction are discussed. Another source of difficulty is the precise definition of the position variables, which must be used in investigations of internal and external interactions. These results enable the construction of a hamiltonian for nuclei with well-defined spins. However, it is preferable to use a nonrelativistic treatment for the motion of the nucleus; such a treatment leads to a phenomenological description of the nuclear moments, which is valid for any spin. (auth) (France)

58800 RELATIVISTIC ATOMIC WAVE FUNCTIONS FOR OPEN SHELLS. **Mayers, D. F. (Oxford Univ.). J. Phys. (Paris), Colloq.; 31: No. 11-12, C.221-4(Nov-Dec 1970).**

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

A simple method of adapting the relativistic Hartree–Fock approximation to configurations involving open shells is described. A shell with angular quantum number j splits relativistically into subshells with $j = 1 + \frac{1}{2}$ and $j = 1 - \frac{1}{2}$, and the electrons can distribute themselves between these subshells in several different ways, giving rise to several different configurations, having very nearly equal energies. The idea of an average of configurations is extended to give a weighted average of all the terms arising from all these configurations. The Hartree–Fock wave functions are then determined for this average configuration; the full Hamiltonian matrix can then be determined, and the energy level scheme found. Results are given for the $(2p)^3$ ground configuration of nitrogen. (auth) (France)

58801 DETERMINATION OF EIGENFUNCTIONS OF THE ANGULAR MOMENTUM OPERATIONS L^2, S^2, AND J^2 IN J–J COUPLING. APPLICATION TO THE STUDY OF SOME RELATIVISTIC EFFECTS. **Bessis, N. (Univ., Lyon); Bessis, G.; Desclaux, J. P. J. Phys. (Paris), Colloq.; 31: No. 11-12, C.231-9(Nov-Dec 1970).**

From International symposium on the theory of atomic structure; Gif-sur-Yvette, France (8 Jul 1970). See CONF-700718.

Within the Slater determinant formalism, a straightforward procedure is given to calculate the simultaneous eigenfunctions of the angular momentum operators L^2, S^2, and J^2 in (j.j) coupling. The set of the eigenfunctions corresponding to any given configuration $(n_1\ l_1)^{x1}\ (n_2\ l_2)^{x2}$... is obtained by diagonalizing a square symmetric matrix. The matrix elements formulas are explicited. This method is well adapted for automatic computation. As an illustration, the (LSJ) wave functions in (j.j) coupling are used as in relativistic calculations for the open-shell case. (auth) (France)

58802 MANY-BODY THEORY OF AUTOIONIZATION. **Yaris, Robert; Boehm, Richard (Washington Univ., St. Louis). J. Chem. Phys.; 55: No. 4, 1802-10(15 Aug 1971).**

By regarding autoionization as the outgoing part of a resonant ion–electron scattering event, it is possible to employ a previously developed many-body theory of elastic and inelastic ion–electron scattering to develop a many-body theory of autoionization. This approach expresses the autoionization probability amplitudes in terms of the ion's one-particle Green's function and response function, which are determined self-consistently. (auth)

58803 MAGNETIC-DIPOLE TRANSITION OPERATOR WITH AN ACCURACY TO α^2 FOR ATOMS WITH ONE OR TWO ELECTRONS. Beigman, I. L.; Safronova, U. I. (Lebedev Inst. of Physics, Moscow. Inst. of Spectroscopy, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 6, 2045-50(Jun 1971). (In Russian).

The usual expansion of atomic functions into powers of $\alpha^2(\alpha = e^2/hc)$ is found to be insufficient for calculation of forbidden-transition probabilities. Terms of the order of α^2 in the expansion of the relativistic transition operator should also be taken into account. An expression for the magnetic-dipole transition operator in one- and two-electron systems is obtained. Probabilities for the single-photon transitions $2s^3S \rightarrow 1s^1S$ and $2s^1S \rightarrow 2s^3S$ are calculated on the basis of this expression for helium-like ions. A similar expansion has also been obtained for electric-dipole transitions. In this case additional terms $\sim\alpha^2$ remove the intercombination restriction for pure LS coupling. (auth)

58804 COMPOUND STATES IN ATOMS AND MOLECULES. **Herzenberg, A. (Univ. of Manchester, Eng.). pp 131-65 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970)**

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

Adaptation of the Kapur–Peierls formalism is carried out, and a few examples of resonance reactions arising in the scattering of electrons from atoms and molecules are cited. An inverse reaction is described, in which an electron-unstable state is produced in a slow collision of an atom and a negative ion. A brief indication of some possible future developments is given. 38 references. (W.D.M.)

58805 SOLUTION OF THE DELTA-FUNCTION MODEL FOR HELIUM-LIKE IONS. **Rosenthal, Carey M. (Univ. of Wisconsin, Madison). J. Chem. Phys.; 55: No. 5, 2474-83 (1 Sep 1971).**

A one-dimensional Fredholm integral equation is derived for the ground-state solution of the delta-function model for two-electron helium-like ions. This equation is solved numerically; the perturbation series is developed through $E^{(20)}$ and compared with the solution of the integral equation. The series is further analyzed in terms of the singularity that determines its radius of convergence. (auth)

58806 STRUCTURE OF SYMMETRY PROPERTIES OF CORRELATION FUNCTIONS IN THE SINANOGLU NONCLOSED-SHELL MANY-ELECTRON THEORY. **Westhaus, Paul (Oklahoma State Univ., Stillwater). J. Chem. Phys.; 55: No. 5, 2507-13(1 Sep 1971).**

The general nonclosed-shell many-electron theory of Sinanoğlu is analyzed to show the structure of the correlation functions that arise. A particular representation of these functions as projections from the exact many-electron wave function is developed. The origin of the three distinct types of correlation effects—internal, semi-internal, and all external—present in open-shell states is discussed. The representation of the correlation functions as projections is employed to examine their transformation properties under the operations of the symmetry group of the Hamiltonian. (auth)

58807 FREQUENCY DISTRIBUTION OF RADIATION EMITTED FROM EXCITED ATOMIC SYSTEMS. **Hearn, Dwight D. (Univ. of Utah, Salt Lake City). Int. J. Quant. Chem.; 5: No. 5, 565-74(Sep 1971).**

General expressions for the time-dependent probability amplitudes of the quantum states of two arbitrary interacting atoms are calculated when one atom is initially in an excited p state and the other atom is in an s ground state. The lifetimes of the excited states and the line shape of the emitted radiation are obtained as functions of both the atomic separation and the energy difference between the excited states of the two atoms. The emission-line shape is shown to be doubly peaked and to agree with the line shape of the radiation scattered by a system of two interacting atoms. The expressions for the lifetimes of the excited states are found to be identical to those obtained for the radiation-scattering situation. (auth)

58808 FURTHER SIGNIFICANCE OF THE PARISER METHOD FOR EVALUATION OF THE ONE-CENTER ELECTRON REPULSION INTEGRAL. **Anno, Tosinobu; Sakai, Yoshiko (Kyushu Univ., Fukuoka). J. Chem. Phys.; 55: No. 6, 2827-31(15 Sep 1971).**

There is a difference between the nonempirical and the semiempirical value of the one-center electron repulsion integral, even if correct recognition is made of the atomic species for which the semiempirical value of the integral is determined with consideration of an electron-transfer reaction according to Pariser. This difference was analyzed for the integral that represents the average interaction of a pair of 2p electrons within an atom. It is shown that the main source of the difference is the failure of the usual nonempirical determination of the integral in considering properly the reorganization of the electrons occurring in the course of the electron-transfer reaction. The correlation energy is shown to have only minor contribution to this difference. (auth)

58809 VAN DER WAALS FORCES INCLUDING EXCHANGE IN THE SMALL OVERLAP REGION. **Boehm, Richard; Yaris, Robert (Washington Univ., St. Louis). J. Chem. Phys.; 55: No. 6, 2620-9(15 Sep 1971).**

A linear-response approach based on the many-body Green's function techniques of Martin and Schwinger is employed to obtain an intermediate-range theory of interatomic forces between ground-state atoms. Electron exchange is included to lowest order in a natural and physically transparent way. The result for the interaction energy is expressible in terms of local and nonlocal response functions associated with the individual atoms. Moreover, the long-range limit of this expression for the interaction energy is explicitly demonstrated to reduce to the familiar van der Waals dispersion interaction. Finally the extension of the linear-response approach to include exchange to the theory of nonadditive three-body interactions is briefly discussed. (auth)

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58810 ERROR BOUNDS TO EXPECTATION VALUES. Mazziotti, Alexander (Johns Hopkins Univ., Baltimore. Columbia Univ., New York). J. Chem. Phys.; 55: No. 6, 2657-60 (15 Sep 1971).

Upper and lower bounds to a true expectation value, P, are given by $(E_{\mu L} - \tilde{E})/\mu \leq P \leq (\tilde{E} - E_{\lambda L})/\lambda$, where $\tilde{E}$ is the variationally minimized energy for the system of interest and $E_{\mu L}$, $E_{\lambda L}$ are lower bounds to the energies associated with reference Hamiltonians, $H_{\lambda}^{\mu} = H \pm {}_{\lambda}^{\mu}\hat{P}$, with $\lambda, \mu > 0$. These bounds are unique in that they are skewed about the approximate expectation value $\tilde{P}$, and because their application is not limited to positive definite operators. Approximate formulas, $dU^2\lambda/d\lambda$ (the derivative of variance with respect to parameter λ in H_{λ}) and $\langle\tilde{\psi} \mid \hat{P}(H-\tilde{E}) \mid \tilde{\psi}\rangle$ (where $\tilde{\psi}$ is an approximate wave function) are shown to give the correct sign of an expectation value error. (auth)

58811 APPLICATION OF RAYLEIGH–SCHROEDINGER PERTURBATION THEORY TO THE HYDROGEN ATOM. II. Gray, B. F. (Univ. of Leeds, Eng.). J. Chem. Phys.; 55: No. 6, 2848-52(15 Sep 1971).

Various unsuccessful attempts to treat the hydrogen-atom problem by perturbation theory, starting from a free particle as the unperturbed state, are examined. Calculations in closed form are presented, confirming the incorrect results but throwing light on the reasons for the failure, which occurs in spite of the fact that convergent power-series expansions in the perturbation parameter exist and are known explicitly. The failure is shown to be essentially due to nonuniform convergence at the point where the boundary conditions are applied, and furthermore this failure occurs for a wide class of potentials besides the Coulomb. Previous methods of avoiding this difficulty for the Coulomb potential are shown not to be of general validity. (auth)

58812 ANALYTICAL RESULT ABOUT CO-OPERATIVE SPONTANEOUS EMISSION. Bonifacio, R.; Gronchi, M. (Univ., Milan). Lett. Nuovo Cim.; 1: No. 26, 1105-8(26 Jun 1971).

The co-operative decay of N two-level atoms is discussed. If the atoms are initially all excited, the variance of the atomic energy increases as N^2 as the system approaches the superradiant state, i.e., that state in which N/2 atoms are in the ground state. A similar behavior is found for the radiated intensity. These results, previously determined from numerical calculations, are verified through an analytical proof. It is found that the relative variance σ/N is independent of the number of atoms; this large variance of the atomic energy during the superradiant pulse from the fully excited state is due to atom–atom correlation and is responsible both for the large deviation of the radiated intensity from the classical value and for the large fluctuation of this intensity. (R.W.R.)

58813 IMPROVED LAMB-SHIFT CALCULATION FOR ALL VALUES OF Z. Erickson, Glen W. (Univ. of California, Davis. Univ. of Surrey, Guildford, Eng.). Phys. Rev. Lett.; 27: No. 12, 780-3(20 Sep 1971).

A previous covariant evaluation of the Lamb shift for small atomic numbers Z is extended to be valid for large Z and agrees with independent numerical evaluations for Z near 80. The results improve the precision tests of quantum electrodynamics and could be used for one-electron atoms with any Z, x rays at large Z, and superheavy elements with $Z\alpha > 1$. A substantially new value (due to deuteron size) is found for the deuterium Lamb shift: 1059.27 ± 0.03 MHz. (auth)

58814 VARIATIONAL POTENTIALS AND LAGRANGIAN MULTIPLIERS IN PSEUDOPOTENTIAL THEORY. Schwarz, W. H. Eugen (Univ., Bonn). J. Chem. Phys.; 55: No. 7, 3607-8(1 Oct 1971).

Use of Lagrangian multipliers in solution of pseudo-Fock equations for closed-shell systems is discussed. It is concluded that—contrary to the Fock equations—use of the Lagrangian multipliers makes the situation worse rather than better and also complicates the numerical procedure. Introduction of the frozen-core approximation into pseudopotential theory is considered briefly. (A.G.W.)

58815 STATISTICAL ATOM MODEL BASED ON A LOCAL COULOMB APPROXIMATION. Ashby, Neil; Holzman, Melvyn A. (Univ. of Colorado, Boulder). pp 1-14 of Topics in Modern Physics. /Brittin, Wesley E. (ed.). Boulder, Colo.; Colorado Associated Univ. Press (1971).

An improved "semistatistical" model capable of incorporating relativistic effects, and which utilizes more precise quantum-mechanical information about the electron density near the nucleus, was discussed by Ashby and Holzman (Phys. Rev., 1: 764 (1970)). Although the semistatistical model gives improved potentials and total energies, it does not exhibit electronic shell structure. This paper presents another model of the atom, intermediate in complexity between the semistatistical and Hartree Self-Consistent Field (SCF) models, which still permits rapid numerical calculation, in which the inner shell structure appears, and which also can be generalized to include relativistic effects. (L.M.T.)

58816 RELATIVISTIC RADIATIVE TRANSITIONS. Garstang, R. H. (Univ. of Colorado, Boulder). pp 153-67 of Topics in Modern Physics. /Brittin, Wesley E. (ed.). Boulder, Colo.; Colorado Associated Univ. Press (1971).

Most calculations on the intensities of spectrum lines have been based on wave functions calculated from solutions of Schrödinger's equation. It was realized by Darwin (Proc. Roy. Soc., A118: 654 (1928)) that if wave functions were obtained from Dirac's relativistic equation the resulting spectroscopic line intensities would be different from the nonrelativistic theory. Darwin pointed out that for hydrogen the difference between the relativistic and nonrelativistic results would be very small, and that for practical purposes the intensity ratios in doublet spectra could be considered as having their usual values. In this article the work that has been done on calculation of relativistic transition probabilities for bound–bound transitions, primarily for hydrogen-like atoms, is surveyed. 37 references. (auth)

58817 CORRELATION OF THE SCREENING CONSTANTS FOR THE K LEVEL FOR ATOMS OF DIFFERENT Z. Gokhale, B. G.; Sahai, Vineet (Lucknow Univ., India). Indian J. Pure Appl. Physics.; 9: No. 3, 190-2(Mar 1971).

The value of Sommerfeld's screening constant σ_1 was calculated for the K level in a number of atoms, and it is shown that it agrees well with the single screening constant introduced by C. Mande and P. S. Damle [Indian J. Pure Appl. Phys., 3: 142, (1965)]. The slight disagreement for higher values of Z is attributed to the interpenetration of electronic shells. (auth)

58818 GROUND STATE ENERGY OF TWO-ELECTRON ATOMS WITH ARBITRARY NUCLEAR CHARGES $Z \leq 137$. Klimchitskaya, G. L.; Labzovskii, L. N. (Leningrad State Univ.). Zh. Eksp. Teor. Fiz.; 60: No. 6, 2019-25 (Jun 1971). (In Russian).

The ground-state energy of a two-electron atom with an arbitrary nuclear charge Z is calculated on the basis of quantum electrodynamics perturbation theory. The zero approximation is envisaged as two noninteracting Dirac electrons in the Coulomb field of the nucleus. Corrections of the first and second order with respect to Coulomb interaction between the electrons are calculated. A variational principle is proposed for second-order corrections. All corrections are calculated as functions of Z in the interval $1 \leq Z \leq 137$. (auth)

58819 FORMULA FOR RELATIVISTIC ATOMIC ENERGIES. Snyder, R. (Harvard Univ., Cambridge, Mass.). J. Phys., B (London); 4: No. 9, 1150-62(Sep 1971).

A formula is presented, which expresses the relativistic energy of many-electron atoms and ions as a simple function of the configuration quantum numbers and of the nuclear charge Z. For systems containing only 1s, 2s, and 2p electrons, the formula involves a four-by-four matrix $\sigma(i|j)$, whose sixteen elements are determined by thirteen theoretical Z-expansion coefficients and by three empirical parameters. The doublet splittings of $1s^22p\ ^2P$, $1s^22s^22p\ ^2P$, $1s^22p^5\ ^2P$, and $1s^22s^22p^5\ ^2P$ are treated, and the results are compared with spin–orbit results and with first-order Z-expansion treatments. The accuracy of the formula is found to be comparable with that of the most accurate spin–orbit calculations. The effects of configuration mixing on the $1s^22s^22p\ ^2P$ and $1s^22p^5\ ^2P$ splittings are discussed in an appendix. Relativistic corrections to the ionization potentials of $1s^22s$, $1s^22s^2$, $1s^22s^22p$, and $1s^22s^22p^6$ are calculated. (auth) (UK)

58820 DAMPING OF PLASMA OSCILLATIONS IN ATOMS. Sen, Abhijit. Knoxville, Tenn.; Univ. of Tennessee (1970). 113p. University Microfilms Order No. 71-17,774.
Thesis.

An attempt is made to resolve the question of the existence of collective (plasma) oscillations in atoms by calculating the damping. These oscillations have energies above the ionization potentials of the atoms and decay by the excitation of bound electrons to free states. Numerical estimates of the damping are obtained for a range of atomic numbers and frequencies, using two different models of the atom—the Jensen model and the Thomas–Fermi model. It is found that in some cases the decay time is much longer than the period of oscillation. It is concluded that weakly damped plasma oscillations can exist in atoms. (Diss. Abstr. Int., B)

58821 APPLICATION OF THE FACTORIZATION METHOD AND GROUP THEORY TO THE RELATIVISTIC TREATMENT OF HYDROGENIC RADIAL FUNCTIONS. **Crubellier, A.; Feneuille, S. (CNRS, Orsay, France). J. Phys. (Paris); 32: Nos. 5-6, 405-11(May 1971). (In French).**

It is shown that the relativistic expression for the radial functions of the bound states of a hydrogenic atom can be used in conjunction with the generalized solution of the Kepler problem if the factorization method and group theory [0(2,1)] are simultaneously introduced. In this way a certain number of simple results were obtained for the radial matrix elements of r^K and r^{-K}. These results are applied to the relativistic treatment of the Zeeman effect (Breit–Margenau correction) and to the hyperfine structure (Casimir corrections). (France)

Cosmic Radiation

Refer also to abstracts 57791, 58443, 58548, 59115, 59245, 59247, 59249, 59274, 59343, 59417, and 59529.

58822 COUPLING FUNCTIONS APPLICABLE TO THE UNDERGROUND MESON TELESCOPES. **Ahluwalia, H. S.; Ericksen, J. H. (Univ. of New Mexico, Albuquerque). J. Geophys. Res.; 76: No. 28, 6613-27(1 Oct 1971).**

A new procedure is proposed for determining the effective primary threshold energy (E_0) applicable to an underground meson telescope located at a moderate depth. E_0 so derived is used in Dorman's procedure for calculating the coupling functions for the underground meson telescopes from coupling functions applicable to a sea-level meson telescope. In this manner the coupling functions are derived for the underground meson telescopes located at 40 and 60 mwe under rock below sea level. The practical usefulness of these functions is demonstrated for the study of the rigidity dependence of the mean solar diurnal variation for the period January 1, 1968, to June 30, 1969, and the Forbush decrease of July 13, 1961. It is concluded that the median primary energy of response of an underground meson telescope is much lower than has been believed. (auth)

58823 COMPARATIVE STUDY OF THE RIGIDITY DEPENDENCE OF FORBUSH DECREASES AND 11-YEAR VARIATION IN COSMIC-RAY INTENSITY. **Mathews, T.; Stoker, P. H.; Wilson, B. G. (Univ. of Calgary, Alberta, Can.). Planet. Space Sci.; 19: No. 8, 981-91(Aug 1971).**

Results of a comparative study of Forbush decreases and the 11-year variation observed at Calgary, Sulphur Mountain, and other neutron monitor stations during the current cycle of solar activity are presented. The 11-year variation since 1965 is well accounted for by a modulation function of the form $e^{-k(t)/P}$, the same as that found suitable for the previous solar cycle. No definite difference between modulation functions applicable to Forbush decreases and 11 year variation from a comparative analysis of data on daily average counting rates from different latitude stations was found. However, hourly data from Calgary and Sulphur Mountain do suggest a difference in modulation at low rigidities, the modulation tending to become rigidity-independent. (auth) (UK)

58824 SOLAR DIURNAL VARIATION OF COSMIC RAYS AT THE 1954 SOLAR MINIMUM. **Thomson, D. M. (Makerere Univ., Kampala, Uganda). Planet. Space Sci.; 19: No. 9, 1169-83(Sep 1971).**

A re-examination of cosmic-ray data at the 1954 solar minimum shows that the anomalous diurnal variation during July, August, and September 1954 was not a sidereal time effect but was associated with a streaming of cosmic rays in a direction perpendicular to the interplanetary-field lines and towards the Sun. The phenomenon is discussed in terms of the theory of diffusion and scattering of cosmic rays in the interplanetary medium. It is shown that the phenomenon could have been the result of an additional gradient in cosmic-ray density due to asymmetric modulation of cosmic rays north and south of the ecliptic plane. Assuming that the interplanetary field was predominantly directed towards the Sun the effect implied a shift of the effective minimum of cosmic-ray density by some 15° northwards from the ecliptic. It is surmised that this asymmetric modulation may have some connection with the asymmetry in solar activity at the 1964–1965 solar minimum. Reasons are given for supposing that such "reverse streaming" of cosmic rays is likely to occur only close to solar minima. (auth)

58825 PERIODIC VARIATIONS OF THE COSMIC RADIATION. II. THE SIDEREAL TIME PERIOD. **Messerschmidt, W. (Martin-Luther Univ., Halle, Ger.). Planet. Space Sci.; 19: No. 9, 1025-40(Sep 1971).**

An approach is made to an evidence of the sidereal time period of the cosmic radiation. The evaluation is based on measurements at 6 stations. In order to observe the properties of the sidereal time period for a long time, the data were classified into time intervals according to the different solar activity or they were summed up over eight to ten years. The analysis can only be carried out if some simplifying assumptions are made. The sidereal time period is supposed to be constant and the daily period should only show a seasonal modulation of the amplitude. For correcting the sidereal time period obtained, the method of Farley and Storey (1954) was applied. It uses one side band of the daily period —the anti-sidereal time period —to gain the genuine sidereal time period by removing the influence of the spurious sidereal time period. The monthly course of the daily period was reconstructed in three typical examples with the help of the established yearly means of the daily period, the sidereal time period and the anti-sidereal time period. The evidence of the sidereal time period is confirmed. Its amplitude amounts to 0.03 to 0.10%. In the southern hemisphere the maximum lies between 05 and 06 local sidereal time, and in the northern hemisphere between 20 and 21 LST, in good agreement with other authors. (auth)

58826 ABSOLUTE INTENSITIES OF COSMIC RAY MUONS ABOVE 3.48 AND 7.12 GeV/c. **Ayre, C. A. (Univ. of Durham, Eng.). J. Phys., A (London); 4: No. 5, L89-93(Sep 1971).**

The new Durham spectrograph MARS was used to determine absolute intensities of cosmic-ray muons in the near vertical direction with momenta above 3.48 and 7.12 GeV/c. The intensities are found to be close to those previously reported by Aurela and Wolfendale in 1967, the present intensities being higher by some (7.7 ± 1.3)% and (1.7 ± 1.4)%, at the respective momenta. Comparison is also made with the results of other recent measurements. (auth)

58827 COUPLING BETWEEN PRIMARY AND SECONDARY COSMIC-RAY MUON VARIATIONS AT HIGH ENERGIES. **Bedewi, F. El.; Goned, A. (Ein Shams Univ., Cairo). J. Phys., A (London); 4: No. 5, 660-4(Sep 1971).**

The muon sea-level integral multiplicity and the coefficients of coupling between primary and secondary muon variations were derived as functions of primary energy for various absorber thicknesses and zenith angles using the Cocconi–Koester–Perkins interaction model. The calculated multiplicities were found to agree at low energies with those derived from geomagnetic data and to be in general accordance with those obtained from nucleon cascade calculations at high energies. The calculated coupling coefficients were observed to depend weakly on zenith angle and to change with primary energy E as E^3 at low energies and as $E^{-2.2}$ for energies above 500 GeV. (auth)

58828 GROUPS OF PARALLEL PENETRATING PARTICLES AND THEIR POSSIBLE SOURCES. **Bibilashvili, M. F. (Inst. of Physics, Tbilisi, USSR). JETP Lett. (USSR) (Engl. Transl.); 13: No. 11, 457-9(5 Jun 1971).**

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 11, 643-6(5 Jun 1971).

A spark calorimeter was used to describe groups of penetrating particles at depths on the order of several hundred kg/cm^2 when most of the particles forming these groups represent muons produced trivially in decays of pions or kaons in the atmosphere. The procedure involves assuming four regions arbitrarily called small bursts-small distances, large bursts-small distance, small bursts-large distances, and large bursts-large distances. The correlation between the spatial and energy characteristics in groups of two, three, or four particles was investigated using data on the angular distributions. The procedure shows that at least three processes are responsible for the production of groups of penetrating particles and that the characteristics obtained make it possible to estimate a parameter such as the X-hadron mass. (J.C.W.)

58829 X- AND γ-RAY ASTRONOMY AND THE TD-1, HEOS-B, AND COS-B SATELLITE MISSION. **Koch, L. (CEN de Saclay, Gif-sur-Yvette, France). Rech. Spatial.; 10: No. 3, 18-20(May 1971). (In French).**

The principal characteristics of equipment that will be aboard the TD-1, HEOS-B, and COS-B satellites are given: the x and γ detectors of the TD-1 satellite and the gamma-ray telescope operating in the 30-MeV to 2-GeV range from the COS-B satellite. (France)

58830 COSMIC ELECTRON ACCELERATION AND THE SPECTRUM OF METAGALACTIC X RAYS. **Dolginov, A. Z.; Gnedin, Yu. N. (Ioffe Inst. of Physics and Tech., Leningrad). Astrophys. Lett.; 9: No. 2, 91-4(Sep 1971).**

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The power spectrum of cosmic relativistic electrons is explained as due to the acceleration and scattering of electrons in turbulent plasma with a frozen-in magnetic field. It is shown that the bends in the electron spectrum may be due not only to synchrotron or inverse Compton-effect losses but also to a change in the energy dependence of the acceleration rate. In this case the break in the spectrum is not restricted to unity. A possibility is discussed of explaining the bend in the metagalactic x-ray spectrum as a result of the bend in the electron spectrum. (auth)

58831 COSMIC GAMMA-RAY MEASUREMENTS IN THE RANGE 0.3 TO 3.7 MeV. Golenetskii, S. V.; Mazets, E. P.; Il'inskii, V. N.; (and others) (Ioffe Inst. of Physics and Tech., Leningrad). Astrophys. Lett.; 9: No. 2, 69-74(Sep 1971).

A study of the spectrum, latitude dependence, and time variations of the low-energy gamma-radiation intensity was carried out in the vicinity of the Earth on the Cosmos 135 and Cosmos 163 satellites by means of a multi-channel scintillation spectrometer. An upper limit for the flux of primary gamma-radiation was obtained in some energy intervals. The estimates obtained lie considerably below the values derived from measurements in the interplanetary space. Possible reasons for these discrepancies are discussed. (auth)

58832 EXTRATERRESTRIAL γ-RAY CONTRIBUTION BETWEEN 0.7 AND 4.5 MeV AT BALLOON ALTITUDE. Vedrenne, G.; Albernhe, F.; Martin, I.; Talon, R. (Centre d'Etude Spatiale des Rayonnements, Toulouse). Astron. Astrophys.; 15: No. 1, 50-4(Nov 1971).

The comparison of γ-ray results obtained through balloon flights at different latitudes enables an extraterrestrial contribution for γ rays to be detected in the 1 to 5 MeV energy range. The method for obtaining this γ-ray flux and its spectrum is described for a flight at low latitude (Guiana 10°N). The results seem to confirm the ERS 18 measurements in a similar energy range and to prove that the γ-ray cosmic component can be detected through balloon experiments. Other flights with larger detectors are planned to confirm these results and increase precision in the determination of this spectrum with, at the same time, an attempt to extend the spectrum to higher energy. (auth)

58833 RELATIVE ABUNDANCES OF THE ISOTOPES OF LIGHT NUCLEI (Li, Be, AND B) IN THE PRIMARY COSMIC RADIATION. Durgaprasad, N. (Tata Inst. of Fundamental Research, Bombay). Astrophys. Space Sci.; 12: No. 1, 243-9 (Jul 1971).

Studies were made to determine the relative abundances of the isotopes of lithium and boron in the primary cosmic rays in the low energy interval 120 to 400 MeV per nucleon recorded in the emulsion stack flown from Fort Churchill. Two independent measurements of mass, wherever possible, were made on each track by the range vs ionization method. The results obtained on nine stopping boron nuclei and two lithium nuclei are presented. (auth)

58834 RATIO OF PIONS TO PROTONS AND RATIO OF NEUTRAL-TO-CHARGED INTERACTING PARTICLES AT MOUNTAIN ALTITUDE OF 800 gm/cm^2. Lal, S.; Raghavan, R.; Rangaswamy, T. N.; Sreekantan, V.; Subramanian, A. (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A; 73: No. 5, 213-22(May 1971).

Using a combined set-up of a multiplate cloud chamber, an air Cherenkov counter, and a total absorption spectrometer, the ratio of pions to protons not associated with large air showers was determined to be 0.50 ± 0.07 in the energy region 20 to 40 GeV at an altitude of 800 gm/cm^2. In the same energy region the ratio of neutral to charged particles was found to be 0.66 ± 0.07. From the ratio of neutrons to protons deduced from these measurements (i.e., 0.99 ± 11), it is concluded that most of the charge excess of nuclear-active particles of energies >20 GeV at mountain altitudes and sea level is due to pions. (auth)

58835 INVESTIGATION OF γ RADIATION BY THE ARTIFICIAL EARTH SATELLITE COSMOS-135. Konstantinov, B. P.; Golenetskii, S. V.; Mazets, E. P.; (and others). Cosmic Res. (USSR) (Engl. Transl.); 8: No. 6, 842-8(Nov-Dec 1970).

Translated from Kosm. Issled.; 8: No. 6, 923-30(Nov-Dec 1970).

The satellite Cosmos-135 conducted measurements of the space and time distributions of the intensity and spectral composition of γ radiation in the 0.3 to 2.7-MeV energy range using a multichannel scintillation γ spectrometer. A study was made of the accompanying measurements of the background effects which are caused by the secondary radiation which develops in the materials of the satellite and the detector itself due to the action of cosmic rays and captured radiation. The dependences of the magnitudes of the 0.4- to 2.5-MeV γ-radiation flux, the annihilation 0.511-MeV γ-radiation flux, and the flux of charged particles on the geomagnetic threshold hardness were obtained. The flux of γ quanta of extra-atmospheric origin in the indicated energy range was determined and was found to be about 0.35 ± 0.15 cm$^{-2}\cdot$sec^{-1}. (auth)

58836 INVESTIGATION OF VARIATIONS OF ANNIHILATION γ RADIATION BY THE ARTIFICIAL EARTH SATELLITE COSMOS-135 IN CONNECTION WITH THE POSSIBLE ANTIMATTER NATURE OF METEOR STREAMS. Konstantinov, B. P.; Golenetskii, S. V.; Mazets, E. P.; (and others). Cosmic Res. (USSR) (Engl. Trans.); 8: No. 6, 849-55(Nov-Dec 1970).

Translated from Kosm. Issled.; 8: No. 6, 931-8(Nov-Dec 1970).

The time variations of the intensity and spectral composition of γ radiation in near space were investigated in the 0.3- to 2.7-MeV energy range. The investigations were carried out during the epoch of the Geminide, Urside, and Quadrantide meteor streams during the winter of 1966–1967 in connection with the previously stated hypothesis of the possible antimatter nature of comets and meteor streams. The data obtained indicate that periods of considerable increase in the intensity of annihilation radiation having an energy of 0.511 MeV are observed. The effect amounts to ~50%. It does not involve the γ-radiation intensities in the remaining ranges of the spectrum investigated nor the intensity of charged particles. The increased intensity of the 0.511-MeV line was observed during the Geminide and Urside meteor streams. Evidently, no connection can be traced between the observed effect and the solar or geomagnetic activity. On the assumption that the discussed hypothesis is valid, the magnitude of the effect can be explained by an amount of antimatter ~20 mg introduced into the Earth's atmosphere during 1 day. (auth)

58837 SUPRATHERMAL PROTON BREMSSTRAHLUNG BY THE WEIZSAECKER–WILLIAMS METHOD. Jones, Frank C. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 169: No. 3, 503-6(1 Nov 1971).

The Weizsäcker–Williams method for calculating the bremsstrahlung cross section utilizes the rest frame of the electron as the natural frame in which to carry out the calculation in terms of Compton scattering the virtual photons of the proton electromagnetic field. Since suprathermal proton bremsstrahlung is a process in which the electron is initially at rest and the proton is moving, the Weizsäcker–Williams method is obviously the most natural one to use in this case. In this paper the cross section for suprathermal proton bremsstrahlung is calculated by means of this method, and the results are shown to differ considerably from those of a previous paper in which the conventional and much more difficult method was used. In particular it is concluded that the the suprathermal proton bremsstahlung process cannot explain the 2 to 6-MeV γ rays reported by Vette et al. (auth)

Direct Energy Conversion

Refer also to abstracts 57671 and 60199.

58838 (N–71–26273) ELECTRIC SPACE POTENTIAL IN A CESIUM THERMIONIC DIODE. Shimada, K.; Cannon, W. (Jet Propulsion Lab., Pasadena, Calif.). 31 Mar 1971. Contract NAS7-100. 19p. (NASA-CR-118519; JPL-TM-33-480). NTIS.

To investigate cesium plasma parameters required for a minimum plasma-loss operation of thermionic converters, a metal–ceramic device equipped with a movable Langmuir probe was constructed. The probe characteristics were examined for four different modes of cesium discharge including: (1) extinguished mode, (2) anode glow mode, (3) ball-of-fire mode, and (4) plasma mode to determine the space potentials and the electron energies in the plasma. The process of cesium ionization that is influenced strongly by the electric potential gradient is being studied to yield a minimum plasma-loss operation. (auth) (STAR)

58839 (TEE–4125–5) THERMIONIC PERFORMANCE OF CVD TUNGSTEN EMITTERS WITH NIOBIUM AND MOLYBDENUM COLLECTORS. Lieb, D.; Rufeh, F. (Thermo Electron Corp., Waltham, Mass.). May 1971. Contract AT(30-1)-4125. 78p. (TE–4137-134-71). Dep. NTIS.

Two chloride vapor-deposited W emitters were installed in variable spacing converters with Nb and Mo collectors. Thermionic performance data were collected in the form of current density–output voltage curves with cesium families and cesium optimized envelopes for various spacings and temperatures. The performance was compared with that of other converters having ⟨110⟩ and ⟨100⟩ W emitters. The effects of rebuilding one

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converter and of collector temperature on performance were studied. (D.L.C.)

58840 INDUKTSIONNYE MAGNITOGODRODINAMICHESKIE MASHINY S ZHIDKOMETALLICHESKIM RABOCHIM TELOM. (Magnetohydrodynamic Induction Machines with Liquid-Metal Working Fluid). Vol'bek, A. I. Leningrad; Energiya Leningradskoe Otdelenne (1970). 272p.

The principles of operation and the construction of various types of inductive magnetohydrodynamic machines with a working fluid of liquid metal are examined. Attention is focused on liquid metal transport and the generation of electric power with a variety of coil windings for a single and multiphase operation. (K.S.W.)

58841 MHD POWER PLANT USING A LIQUID METAL EMULSION WITH GAS TURBINES ASSOCIATED WITH A HIGH TEMPERATURE GAS REACTOR. Bidard, Rene; Sterlini, Jacques (Compagnie Electro-Mecanique, Le Bourget, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 88, 29-38 (Mar 1971). (In French).

The problem of coupling an emulsion MHD generator with an HTR and the various solutions obtained from a basic family of perfect cycles are examined. The energy per mass unit available in these various cycles depends on the compression ratio chosen. It is enhanced by circulating in the reactor a gas coolant with a flow rate greater than that of the thermodynamic gas and by inserting a heat exchanger between the reactor and the generator. The case of an emulsion heat exchanger is envisaged and a theoretical calculation is given. The use of two gas turbines coupled in parallel is shown to yield a very attractive cycle. For a reactor working at 1500°K, a thermal efficiency in excess of 53% can be reached provided that the generator has an internal efficiency of 0.8 and the highest temperature before the gas turbine is not greater than 1,100°K (827°C). This efficiency is comparable with that announced by the authors (IAEA Colloquium, Salzburg, July 4 to 8, 1966 (SM-74/108)) in the case of the coupling with a sodium-cooled reactor. (auth)

Fluid Physics

Refer also to abstract 59216.

58842 ELECTROHYDROMAGNETIC INSTABILITY OF SUPERPOSED FLUIDS. Bhowmik, G.; Talwar, S. P. (Univ. of Delhi). Appl. Sci. Res. (The Hague); 24: No. 2-3, 213-25 (Jun 1971).

The problem of stability of superposed viscous liquids subject simultaneously to electric and magnetic fields is investigated using the normal mode analysis. A configuration of an electrically conducting liquid topped by a dielectric liquid is envisaged in a downward gravity field. The electric field is assumed along the gravity field, while the magnetic field is taken to be either along or normal to the electric field. Criteria of instability are derived in both cases. It is found that a vertical electric field has a destabilizing influence and renders an otherwise stable configuration (bottom heavy arrangement) unstable for small wavelengths, while the effect of the magnetic field is stabilizing. (auth)

58843 TWO-DIMENSIONAL MAGNETOHYDRODYNAMIC CHANNEL FLOW IN A NONUNIFORM MAGNETIC FIELD. Urashima, Shin-o (Osaka Univ.). J. Phys. Soc. Jap.; 31: No. 4, 1249-58(Oct 1971).

A circular magnetic field is applied to the channel. The fluid is inviscid and thermally nonconductive. The electrical conductivity of the fluid is assumed to be small so that the distortion of the magnetic field is neglected. The basic equations are linearized and the solution is obtained by the method of Fourier transforms. The solutions consist of two parts, including three parameters: the Mach number, the interaction parameters, and the interval between the walls. One part comes from the interaction between the fluid and the magnetic field. The other is the interaction between the fluid and walls. The flow accelerates in the channel for the subsonic case. This fact indicates that the effect of the Joule heating overcomes the Lorentz force in the case of channel flow across the nonuniform magnetic field. (auth)

58844 CURRENT AND POTENTIAL DISTRIBUTIONS IN NONEQUILIBRIUM MHD PLASMAS AT HIGH MAGNETIC FIELD STRENGTHS. Lengyel, Lajos L. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 10, 1957-62(Oct 1971).

The method of characteristics is applied to steady-state two-dimensional current and potential distributions in loss-free nonequilibrium MHD plasmas. The existence conditions of real characteristics are analyzed; the characteristic directions are defined and the corresponding compatibility relations are found. In an approximation corresponding to low ionization degree and moderate electron temperature elevation, analytic solutions are obtained for two particular cases: neutral collision and Coulomb-collision-dominated plasmas. The two families of characteristics are shown to coincide (neutral collisions) or nearly coincide (Coulomb collisions) with current streamlines and electric field lines. At magnetic field strengths above a critical value the discharge becomes striated even in ideal perturbation-free plasmas. The current flowing from electrode to electrode contracts to filaments of elevated current density. The solution indicates the existence of eddy currents in the system which consume a part of the applied (or induced) voltage, thus impairing the attainable electrical efficiencies. (auth)

58845 OPTIMAL DISTRIBUTION OF A TENSOR OF SPECIFIC RESISTANCE OF A WORKING SUBSTANCE IN A MAGNETOHYDRODYNAMIC DUCT (CASE OF NONLOCAL VARIATIONS). Lur'e, K. A. Prikl. Mat. Mekh.; 35: No. 3, 512-31(May-Jun 1971). (In Russian).

Current maximization in the outer loop of a duct was studied by means of selecting a tensor with a given specific resistance of the working substance. In the statement of the problem a plane duct is considered, the walls of which are a dielectric throughout. In a second variant, the essential conditions of Jacob are treated mathematically, and last, in the case of the "short circuit," the duct is assumed to be bounded by horizontal electrodes and vertical insulators. The possibility of a satisfactory approximation to an optimum current value is discussed in the case of horizontal insulating partitions inserted in the duct. (K.S.W.)

58846 NEARLY SYMMETRIC KINEMATIC AND HYDROMAGNETIC DYNAMOS. Soward, A. M. (New York Univ., N. Y.). J. Math. Phys. (N. Y.); 12: No. 9, 1900-6(Sep 1971).

Certain aspects of the hydromagnetic and kinematic dynamo theory related to the earth's magnetic field are considered. Previous work on the hydromagnetic dynamo is extended in two respects. First, the most general form of the prescribed body force which is consistent with the model is considered. Secondly, the mean quantity $\langle S_\phi \rangle$ is determined up to order $R^{-\frac{1}{2}}$, where R is the magnetic Reynolds number. It is shown that the remarkable effective variables first introduced previously are relevant in the hydromagnetic dynamo in the second approximation. It is also shown by considering a related problem concerning the heat conduction equation that effective variables are unlikely to have any relevance in the kinematic dynamo theory in the third approximation. (auth)

58847 PLANE NONSTATIONARY MAGNETOHYDRODYNAMIC BOUNDARY LAYER. Pop, Ioan. Stud. Univ. Babes-Bolyai, Ser. Math.-Mech.; 16: No. 1, 87-93(1971). (In French).

The effect of a magnetic field, changing in space and time, is studied at a break in the plane boundary layer from a body that suddenly begins to move from rest. The method of "similar" solution is employed, i.e., the conversion of the boundary-layer equations into ordinary differential equations, the solution to which is produced in closed form. It is noted in the case of a circular cylinder that, as the magnetic field increases, the break in the boundary layer occurs later. (tr-auth)

58848 STABILITY OF COMPRESSION SHOCK IN MAGNETOGASDYNAMIC FLOWS IN CHANNELS. Slobodkina, F. A. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 16-23(Jan-Feb 1970). (In Russian).

The effect of the form of the boundary conditions in the exit cross section of the channel on stabilization of compression shocks in gasdynamic and magnetogasdynamic flows at small magnetic Reynolds numbers is demonstrated. Criteria for stabilization of shocks located near the channel exit are obtained. The influence of electromagnetic effects was studied. (tr-auth)

58849 ELECTRODYNAMICS OF TURBULENT MOVING ELECTRICALLY CONDUCTING MEDIA WITH CONSIDERATION OF THE HALL EFFECT. Helmis, G. (Deutsche Akademie der Wissenschaften, Berlin). Cosmic Electrodyn.; 2: No. 2, 197-210(Jul 1971). (In German).

The mean value of v × B in a turbulently moving electrically conducting medium is calculated, taking into account the influence of the Hall effect. The turbulence is assumed to be homogeneous, isotopic, but not symmetric with respect to reflection. General expressions are developed for small turbulence velocities; exactly valid formulas are derived for special correlation tensors and any value of conductivity and the Hall parameter. It follows from the calculations that the mean value of v × B decreases with increasing Hall parameter, but the influence of the Hall effect is reduced by increasing electrical conductivity. (tr-auth)

58850 DISTRIBUTION DISCONTINUITIES OF ELECTRIC CURRENTS AND FIELDS IN FLOWS WITH THIN LAYERS OF HIGHLY CONDUCTING GAS. Kholshchevnikova, E. K. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 39-43(Jan-Feb 1970). (In Russian).

On the basis of solutions obtained by the Fourier method, the effect of a highly conducting thin gas layer on Joule dissipation and current distribution in the end zone of a plane MHD duct with nonconducting walls is analyzed. It is assumed that the MHD interaction parameter, magnetic Reynolds number, and Hall parameter are small. It was found that in some cases it is possible to replace the highly conducting thin layer by surface dislocations and still effect completely the definite relations between electric magnitudes. The presence of such a layer leads to an increase of Joule dissipation and to a decrease of the lines of current. (tr-auth)

58851 STABILITY OF AN EXPLICIT SCHEME FOR THE JOINT SOLUTION OF THE ENERGY EQUATION AND THE RADIATION TRANSFER EQUATION. Chetverushkin, B. N. (Inst. for Applied Mathematics, Moscow). Chislennye Metody Mekh. Sploshnoi Sredy; 1: No. 1, 95-9(1970). (In Russian).

If there is no equilibrium between the matter and the radiation, the radiative gasdynamic problem is solved by means of the transfer equation. The flux obtained depends on the temperature in all points of the space. It was considered simpler to solve simultaneously the energy equation and the radiation transfer equation, determining the flux on the basis of data from the preceding time step. The stability of such an explicit scheme was investigated, transposing the results to a generalized case by linearization. The thus obtained condition agreed with the stability condition of an explicit scheme of the nonstationary thermal-conductivity equation. (TTT)

Geophysics (Upper Atmosphere)

Refer also to abstracts 57790 and 58849.

58852 (LA-tr-71-69) SOLAR WIND PARAMETER VARIATION, MAGNETIC ACTIVITY, AND ELECTRONS OF THE TAIL OF THE MAGNETOSPHERE AND THE RADIATION ZONE. Ivanov, K. G.; Mikerina, N. V. (Akademiya Nauk SSSR, Moscow. Institut Zemnogo Magnetizma, Ionosfery i Rasprostraneniya Radiovoln). Translated by Helen Dahlby (Los Alamos Scientific Lab., N. Mex.), from Russian Preprint No. 2. 15p. Dep. NTIS.

Data from previous works are used to analyze the solar-wind parameter variation and magnetic activity. A high correlation is expected from the magnetic-activity variations with the variations of the southern component, F_S, of the magnetic field or the eastern component, E_E, of the electric field of the solar wind. The variations of the magnetic activity are fairly closely related to the electron variations in the magnetotail, and it can then be assumed that a relation exists between the solar-wind parameters and the characteristics of the electron fluxes of the magnetosphere. An attempt was made to find a relationship from the data on electrons during the periods of Sept. 26, 1966 and July 5–12, 1966 for the magnetospheric storms for which there are observations on the solar-wind correlation with the F_S, E_E, K_p, and the magnetic flux, ϕ. 34 references. (J.C.W.)

58853 (N-71-27792) RISK OF SOLAR PROTON EVENTS TO SPACE MISSIONS. Burrell, M. O. (National Aeronautics and Space Administration, Huntsville, Ala. George C. Marshall Space Flight Center). Jun 1971. 84p. (NASA-TN-D-6379). NTIS.

The total dose from solar protons was tabulated in rads-tissue for weekly time intervals, and the number of weeks that gave a dose above 25 rads behind 10 g/sq m of aluminum for the active six years of the 19th cycle were called dangerous or large-event weeks. Only three such event weeks were found during the past 20 years. Even though the possibility of smaller events was examined, it was found that for any reasonably high confidence level (95%), the smaller events could be ignored. Consequently, the total particle flux for the 19th cycle was divided by a factor of three and a single large event week was determined. The Poisson distribution was the most logical choice for predicting the probability of an event occurring. This conclusion and the methods of using this probability model are examined. The confidence one could use in employing the Poisson process and specifically arriving at confidence levels for the experimental or observed value of the mean of the Poisson distribution function is defined. Several examples are given for different mission lengths, and comparisons to other results are made. (STAR)

58854 LOCATING THE MAGNETOSPHERIC RING CURRENT. Thorne, R. M.; Kennel, C. F. (Univ. of California, Los Angeles). Comments Astrophys. Space Phys.; 3: No. 4, 115-20(Jul-Aug 1971).

Ground-based observations of the geomagnetic field give no clue about the location of the ring current. It is pointed out that 10- to 100-keV protons, which dominate ring-current energetics, have two preferred regions of cyclotron instability and consequently, loss, which serve as stable trapping boundaries for ring-current protons. The pertinent electromagnetic ion cyclotron instability therefore limits the ring current location, and, using the empirical notion that within the stable region the energy density does not exceed the geomagnetic energy density, also the ring-current energy density, and therefore, the main-phase depression. (W.D.M.)

58855 INTERACTION BETWEEN INTERSTELLAR HELIUM AND THE SOLAR WIND. Holzer, T. E.; Axford, W. I. (Univ. of California, San Diego, La Jolla). J. Geophys. Res.; 76: No. 28, 6965-70(1 Oct 1971).

Vela-3A satellite observations suggest that the solar-wind He^+ abundance is occasionally much larger than would be expected if the solar-wind ionization state were determined in the solar corona at temperatures of the order of 10^6°K. A further study is made of the suggestion that photoionization of interstellar helium atoms could produce a sufficiently large number of He^+ ions in the solar wind to explain the Vela-3A data. It is shown that the photoionization of interstellar He atoms can lead to solar-wind He^+ ions with large thermal speeds and nonradial flow velocities, unlike those of other solar-wind ions, and the result is not inconsistent with the satellite data. A helium number density of the order of 10^{-2} cm^{-3} in the interstellar gas appears to be sufficient to produce the observed solar-wind He^+ fluxes. (J.C.W.)

58856 RELATIONSHIP OF INTERPLANETARY PARAMETERS AND OCCURRENCE OF MAGNETOSPHERIC SUBSTORMS. Foster, J. C. (Univ. of Maryland, College Park); Fairfield, D. H.; Ogilvie, K. W.; Rosenberg, T. J. J. Geophys. Res.; 76: No. 28, 6971-5(1 Oct 1971).

Features from 54 substorms were averaged to use in the study of the relationship between magnetic-field parameters, plasma parameters, and magnetospheric substorms on a time scale of approximately 3 min. A southward component of the interplanetary field in producing geomagnetic disturbances was stressed in the studied. It is concluded from the behavior of substorms studied that the solar-wind proton data, and the interplanetary magnetic-field magnitude and equatorial-plane components, do not exhibit any significant morphological features that can be related to geomagnetic-substorm development. The data examined strongly reaffirm the relationship between a southward interplanetary magnetic-field component and the occurrence of substorms and indicate that this relationship is the dominant effect immediately preceding and during substorms. (J.C.W.)

58857 ROCKET MEASUREMENTS OF MAGNETIC FIELDS ASSOCIATED WITH VISUAL AURORAE. Burrows, K.; Stolarik, J. D.; Heppner, J. P. (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci.; 19: No. 8, 877-90(Aug 1971).

The results of two Nike–Tomahawk flights of rubidium vapour magnetometers from Fort Churchill, Canada are presented and discussed, together with relevant ground data. These flights confirm that the electrojet currents tend to concentrate within the boundaries of the visual auroral forms when they are present. As the most pronounced field changes occurred in the 95- to 130-km range of altitudes, they also support the concept that the auroral electrojet currents are predominantly Hall currents. (auth) (UK)

58858 CORRELATION BETWEEN PULSATING AURORA AND COSMIC RADIO NOISE ABSORPTION. Brekke, A. (Auroral Observatory, Tromsoe, Norway). Planet. Space Sci.; 19: No. 8, 891-6(Aug 1971).

A statistical analysis of the correlation between auroral pulsations and auroral absorption at Tromsø was performed for the years 1964 to 68. The two phenomena seem to be completely independent except for perhaps some short periods around midnight and in the late morning hours. A timeshift for the daily maximum of pulsating aurora with the solar activity is seen. (auth) (UK)

58859 CONSTANT-PRESSURE, TAIL-LIKE EXTRUSION OF PLASMA INTO THE CONFINED MAGNETIC FIELD OF A LINE DIPOLE. Hewson-Browne, R. C.; Kendall, P. C. (Univ. of

Sheffield, Eng.). Planet. Space Sci.; 19: No. 8, 869-76(Aug 1971).

A magnetic line-dipole field may be confined within an otherwise empty cavity by an infinitely conducting plasma at constant pressure, free of magnetic field. The problem has applications in the theory of the magnetosphere. The possible configurations are more numerous than has been supposed hitherto. It is shown, in particular, that a cavity is possible with an infinitely long tail-like extrusion into it of plasma at constant pressure. The successful formation of the tail is due to the uniform magnetic pressure outside the tail. The electric currents in the tail distort the otherwise symmetrical cavity, moving the magnetic cusps a little way round its surface onto the side opposite from the tail. The effects of the tail currents are limited, though, by the condition that the tail remains all in one piece. The features of this model which are relevant to the topology of the Earth's magnetosphere are discussed. The problem is solved by the use of conformal transformation in the complex plane. The method is applicable to models in which the plasma sheet is inclined at an arbitrary angle to the axis of the dipole. (auth) (UK)

58860 COMPARISON OF GEOMAGNETIC STORMS AND TROUGH DEVELOPMENT AT SOLAR-ACTIVITY MAXIMUM AND MINIMUM. **Woodbridge, David D. (Florida Inst. of Tech., Melbourne). Planet. Space Sci.; 19: No. 8, 821-6(Aug 1971).**

Geomagnetic storms have long been found to be related to solar storms. However, the effects of solar activity within the lower atmosphere have been postulated but not as yet confirmed. A positive correlation was found between trough development at 300 mb and geomagnetic storms during the 1956 to 57 solar-activity maxima in a study performed at the High Altitude Observatory of the University of Colorado. Similar studies performed at the Army Ballistic Missile Agency and at Florida Institute of Technology also showed positive correlations between geomagnetic storms and subsequent trough development. A comparison of the results of these investigations into a possible solar-weather effect are presented. (auth) (UK)

58861 COMMENT ON TRAJECTORY CALCULATIONS IN THE WILLIAMS AND MEAD GEOMAGNETIC-FIELD MODEL. **Morfill, G. E. (Imperial Coll. of Science and Tech., London). Planet. Space Sci.; 19: No. 8, 1016-18(Aug 1971).**

To study the impact zones associated with the entry of solar protons to the polar ice cap, it is necessary to integrate solar-proton trajectories in a high degree simulation of the geomagnetic field. For this, an accurate field representation out to ~20 Earth radii is required. Reasons for accepting the Williams and Mead field model (Mead, 1964; Williams and Mead, 1965) are given, and limitations of previous work using this model are discussed. The integration of particle trajectories was performed using a modified McCracken (1962) program. The geomagnetic field was described using a 6-term expansion (Finch and Leaten 1957) of the internal field and the Williams and Mead external field due to currents in the magnetopause and tail. The difference between asymptotic approach directions for this 6-term expansion is shown, with trajectories terminated at the magnetopause or at 25 Earth radii along the tail. Good agreement is found for particles crossing the magnetopause on the day side, as the 2-term expansion still holds here, but when going down the tail results may be 50° longitude different. Calculation of the pitch angle for the tail regions allows important conclusions to be reached. (UK)

58862 AMBIPOLAR DIFFUSION ALONG MAGNETIC FIELD LINES IN PRESENCE OF AN ELECTRIC CURRENT. **Scholer, M.; Haerendel, G. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Planet. Space Sci.; 19: No. 8, 915-27 (Aug 1971).**

The one-dimensional ambipolar diffusion parallel to the magnetic field is treated for the case of a plasma cloud imbedded in a weakly ionized gas with a homogeneous magnetic field. Cloud and background ions are distinguished. A constant electric current is allowed to flow from infinity through the cloud. The resulting coupled diffusion equations for cloud and background ions are solved numerically. The initial phase is characterized by distortions of the density distributions of the ions owing to electric polarization fields which are the more pronounced the higher the contribution from the test ions. The peak of the test-ion distribution will finally move in the direction of the electric current. Situations in the F region of the ionosphere where these effects become appreciable are likely to be affected by plasma turbulence and anomalous resistivity. (auth) (UK)

58863 TIME LAGS IN THE AURORAL-ZONE IONOSPHERE. **Reid, J. S.; Phillips, J. (Univ. of Tasmania, Hobart). Planet. Space Sci.; 19: No. 8, 959-69(Aug 1971).**

Fast-response riometers were operated at Macquarie Island (invariant latitude 64°S) in conjunction with balloon-borne x ray scintillators, a λ4278-Å photometer, and a loop for detecting micropulsations. The pulsations in cosmic-noise absorption (CNA) observed with the riometers were found to lag behind pulsations in bremsstrahlung x rays, auroral luminosity, and micropulsations occurring at the same time. These phase lags and the time asymmetry characteristic of CNA pulsations are shown to be consistent with the ionospheric rate equation. (auth) (UK)

58864 THERMOSPHERIC WINDS INDUCED BY AURORAL-ELECTROJET HEATING. **Cole, K. D. (La Troba Univ., Bundoora, Australia). Planet. Space Sci.; 19: No. 8, 1010-12 (Aug 1971).**

It is argued that joule dissipation of magnetospheric electric fields can cause significant winds in the low E region which are part of convection cells, with air rising over auroral electrojets and flowing away (towards) the jets in the upper (lower) thermosphere. Concomitant effects are the meridional transport of a net eastward momentum of the thermosphere acquired by the E × B drift at high altitude over the jets, and the overturning of the thermosphere and mixing of its neutral constituents (this mixing being assisted by spatially irregular joule heating). (auth) (UK)

58865 ROYAL ASTRONOMICAL SOCIETY MEETING ON STORM EFFECTS IN THE IONOSPHERE AND MAGNETOSPHERE, NOV. 20th 1970. **Quart J. Roy. Astron. Soc.; 12: No. 2, 169-79(Jun 1971).**

Brief summaries are given on the following topics: ionospheric storms; correlation between air density and magnetic disturbance deduced from changes in satellite spin rate; vlf radiowave observations of ionospheric disturbances during the period Mar. 4–18, 1970; storm increases of midlatitude F-layer electron concentration explained by modification of neutral air winds; storm effects on topside ionosphere temperatures and in composition; principal zones of elf/vlf emission; problems of interpretation of equatorial magnetic daily variations on disturbed days; storm effects on solar protons; rocket observations of precipitating charged particles above South Uist, Outer Hebrides, during the magnetic storm of April 21–22, 1970; variation of geomagnetic micropulsation periods with latitude and the plasmapause; and morphology of storms. (UK)

58866 VARIATIONS IN THE HIGH-LATITUDE PROTON TRAPPING BOUNDARY ASSOCIATED WITH POLAR MAGNETIC SUBSTORMS. **Lindalen, H. R.; Soeraas, F.; Aarsnes, K.; Amundsen, R. (Univ. of Bergen). Planet. Space Sci.; 19: No. 9, 1041-8(Sep 1971).**

Protons in the energy range (100 to 200) keV in the noon to midnight meridian plane are studied from data obtained by the ESRO-IA satellite. It is observed that during quiet geomagnetic conditions there is a single zone of precipitating protons located at an invariant latitude of 67° on the nightside and two zones located at invariant latitudes of 70 and 77° on the dayside. Closely correlated with the polar magnetic substorm, the proton-trapping boundary moves poleward, the two zones of proton precipitation on the dayside merge into one zone, and the energy input into the atmosphere increases. Preceding the poleward movement of the trapping boundary, there is an intensity increase in the already existing proton precipitation on the nightside. (auth)

58867 DYNAMICAL BEHAVIOR OF THERMAL PROTONS IN THE MIDLATITUDE IONOSPHERE AND MAGNETOSPHERE. **Banks, P. M.; Nagy, A. F.; Axford, W. I. (Univ. of California, San Diego, La Jolla). Planet. Space Sci.; 19: No. 9, 1053-67 (Sep 1971).**

Satellite and other observations have shown that H^+ densities in the midlatitude topside ionosphere are greatly reduced during magnetic storms when the plasmapause and magnetic-field convection move to relatively low L values. In the recovery phase of the magnetic storm the convection region moves to higher L values and replenishment of H^+ in the empty magnetospheric field tubes begins. The upwards flow of H^+, which arises from O^+–H charge exchange, is initially supersonic. However, as the field tubes fill with plasma, a shock front moves downwards toward the ionosphere, eventually converting the upwards flow to subsonic speeds. The duration of this supersonic recovery depends strongly on the volume of the field tube; for example calculations indicate that for L = 5 the time is approximately 22 hours. The subsonic flow continues until diffusive equilibrium is reached or a new magnetic storm begins. Calculations of the density and flux profiles expected during the subsonic phase of the recovery show that diffusive equilibrium is still not reached after an elapsed time of

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10 days and correspondingly there is still a net loss of plasma from the ionosphere to the magnetosphere at that time. This slow recovery of the H^+ density and flux patterns, following magnetic storms, indicates that the midlatitude topside ionosphere may be in a continual dynamic state if the storms occur sufficiently often. (auth)

58868 MONTE CARLO ANALYSIS OF THE PASSAGE OF AURORAL X RAYS THROUGH THE ATMOSPHERE. **Pilkington, G. R.; Anger, C. D. (Univ. of Calgary, Alberta). Planet. Space Sci.; 19: No. 9, 1069-85(Sep 1971).**

The deep penetration of auroral x rays into the atmosphere is examined by means of a Monte Carlo calculation in order to determine the effects of atmospheric scattering and absorption on spectra observed at balloon altitudes. Compton and coherent scattering and photoelectric absorption are taken into account in the calculation. The results show that exponential-type x-ray energy spectra steepen on penetration through the atmosphere in the energy range 50 to 200 keV due to the fact that the majority of x rays reaching typical balloon altitudes between 5 and 20 g/cm^2 have suffered energy degradation from Compton scattering. The slope of the spectrum indicated by a collimated detector is found to be more dependent on source geometry and detector source distance than it is for an omnidirectional detector. In fact, the latter detector causes almost constant and hence predictable spectral distortion, irrespective of source geometry or detector–source distance. Data are provided from which can be deduced the parent x-ray spectrum and flux from balloon measurements for different atmospheric depths, detectors, source geometries, and energy spectra. (auth)

58869 NUMERICAL CALCULATION OF REFLECTION AND TRANSMISSION COEFFICIENTS FOR THIN HIGHLY IONISED LAYERS INCLUDING THE EFFECT OF THE EARTH'S MAGNETIC FIELD. **Chessell, C. I. (Univ. of Melbourne). J. Atmos. Terrest. Phys.; 33: No. 10, 1515-32(Oct 1971).**

A numerical integration process is described which can be used to calculate reflection and transmission coefficients for thin highly ionized layers in the presence of the Earth's magnetic field. Comparisons are made with the results of phase integral methods and the importance of mode coupling demonstrated. Complete reflection and transmission coefficient results are presented for a thin parabolic layer. (auth)

58870 MAGNETO-IONIC MODE COUPLING OF hf RADIO WAVES. **Titheridge, J. E. (Univ. of Auckland, N. Z.). J. Atmos. Terrest. Phys.; 33: No. 10, 1533-40(Oct 1971).**

The effect of coupling between the ordinary (O) and extraordinary (E) components is examined using the coupled wave equations. The coupling in any region is said to be critical when, for initial O and E modes of equal amplitude, the relative phase of the O and E modes emerging from the region is constant and independent of the initial phase. Under these conditions a pure O (or E) wave entering the coupling region emerges as O and E components of equal amplitude. When coupling is greater than the critical value, an increasing phase difference between the initial O and E components becomes a decreasing phase difference after passage through the coupling region. This change produces a reversal in the sign of the Faraday rotation. For a constant value of the coupling ratio Q, critical coupling can occur only if $Q > 1$ over an appreciable distance. When coupling is caused by a steady change in the angle θ between the wave normal and the magnetic field, the overall effect depends only on the peak value of Q (at $\theta = 90°$). (auth)

58871 MODE COUPLING OF hf WAVES IN THE IONOSPHERE. **Titheridge, J. E. (Univ. of Auckland, N. Z.). J. Atmos. Terrest. Phys.; 33: No. 10, 1541-57(Oct 1971).**

Coupling of the ordinary (O) and extraordinary (E) modes in the ionosphere occurs when the angle θ between the wave normal and the magnetic field varies along the ray path. The degree of coupling is specified by a coupling ratio Q. This reaches a maximum at the transverse point ($\theta = 90°$) and coupling is generally confined to a limited region near this point. The overall effect of this coupling region is evaluated using the coupled wave equations. If the peak value of Q(Q_m, at $\theta = 90°$) is greater than 2.3, the Faraday rotation of a signal traversing the coupling region is approximately zero. If $Q_m < 2.3$ the polarization ellipse is reversed at $\theta = 90°$ and the absolute number of Faraday rotations increases throughout the ray path. The coupling then causes a slight increase in the amount of Faraday rotation. Curves are given showing the variation of Q with height in the ionosphere and with zenith angle, for different directions of propagation at latitudes of 2 to 40°. The value of Q_m is primarily a function of height. For a typical F layer with a penetration frequency of 10 MHz and a wave frequency of 40 MHz, $Q_m > 2.3$ only for heights above 500 km or below 200 km at all latitudes. The effect on the Faraday rotation of satellite signals is calculated. (auth)

58872 INTERACTION OF INTERNAL GRAVITY WAVES WITH THE IONOSPHERIC F2 LAYER. **Clark, R. M.; Yeh, K. C.; Liu, C. H. (Univ. of Illinois, Urbana). J. Atmos. Terrest. Phys.; 33: No. 10, 1567-76(Oct 1971).**

A gravity wave produces perturbations in density, velocity, and temperature in the neutral atmosphere. These perturbations in turn modify the ionospheric processes involving photoproduction, chemistry, and transport. The effect of modification of these processes on the F2 ionosphere can be examined by solving numerically the equation of continuity. Extensive computations have shown that the ionospheric response at F2-region heights is quite sensitive to ion drag and diffusion effects. To neglect diffusion may introduce a substantial height-dependent phase shift. It has been found that a gravity wave of perturbation magnitude may induce an ionization change which is not of perturbation magnitude. Under such circumstances, the perturbation analysis cannot be expected to obtain ionospheric response with any desired accuracy for all cases. The phase of atmospheric parameters relative to the ionization perturbation is found to vary continuously with height. (auth)

58873 EFFECT OF EARTH'S MAGNETIC FIELD ON PROPAGATION OF ELF AND VLF RADIO WAVES. **Barr, R. (London Univ.). J. Atmos. Terrest. Phys.; 33: No. 10, 1577-83(Oct 1971).**

Computations were made of the attenuation and phase velocity of elf and vlf radio waves propagating under a realistic inhomogeneous anisotropic ionosphere. By assuming the ionosphere to be representative of the daytime ionosphere at all latitudes and the Earth's magnetic field to be that of a perfect dipole, the azimuthal dependence of elf and vlf propagation was studied as a function of latitude. The azimuthal variation of the propagation constant of the Earth–ionosphere waveguide was found to increase with decreasing latitude, the greatest variation occurring at "attenuation band" frequencies (1 to 4 kHz). A modal degeneracy dependent upon azimuth and latitude was also observed. It is predicted that modal interference will occur at vlf, the effect being greatest for west–east propagation and increasing with decreasing latitude. (auth)

58874 CHARACTERISTICS OF STORM-TIME GEOMAGNETIC DAILY VARIATION. **Kane, R. P. (Physical Research Lab., Ahmedabad, India). J. Atmos. Terrest. Phys.; 33: No. 10, 1585-95(Oct 1971).**

Quiet and disturbed-day daily variations (Sq, Sd) and their difference SD = Sd – Sq are studied for the H component for 1964 for Sverdlovsk, Alibag, Annamalainagar, and Trivandrum (all in 60 to 80°E longitude) after correcting for D_{st} effects which are estimated in two ways; (i) D'_{st} obtained as average of Tashkent and Sabhawala near the Sq focus; and (ii) D''_{st} obtained from SUGIURA and CAIN (1970). The results show that (a) Sq is a predominantly day-time phenomenon of mostly ionospheric origin, (b) SD is diurnal for mild disturbances and semi-diurnal for large disturbances and consists of a morning increase, a sharp noon decrease giving a reverse current, a recovery to positive current by 20 to 22 hr LT, followed by a decay to zero level. Implications regarding ionospheric and non-ionospheric contributions are discussed. (auth)

58875 PHASE-INTEGRAL CORRECTION FOR CALCULATIONS OF RADIO-WAVE ABSORPTION IN THE IONOSPHERE. **Thorpe, M. R. (Univ. of Canterbury, Christchurch, N. Z.). J. Atmos. Terrest. Phys.; 33: No. 10, 1597-1605(Oct 1971).**

The absorption of radio waves reflected in the ionosphere may be calculated by the phase integral method. An analytic expression is derived for the phase integral correction to the absorption as calculated by ray theory. The expression is shown to be of adequate accuracy for most conditions of propagation, and represents a correction of about 10% for frequencies near 2 MHz. (auth)

58876 SOME PULSE CHARACTERISTICS OF ATMOSPHERIC RADIO-NOISE BURSTS AT 3 MHz. **Shivaprasad, A. P. (Indian Inst. of Science, Bangalore). J. Atmos. Terrest. Phys.; 33: No. 10, 1607-19(Oct 1971).**

An atmospheric radio-noise burst represents the radiation received from one complete lightning flash at the frequency to which a receiver is tuned and within the receiver bandwidth. At tropical latitudes, the principal source of interference in the frequency range from 0.1 to 10 MHz is the burst form of atmospheric radio noise. The structure of a burst shows several approximately rectangular pulses of random amplitude, duration, and frequency of recurrence. The influence of the noise on data communication can only be examined when the value of the number of pulses crossing a certain amplitude threshold per unit time of the noise burst is known. A pulse-rate counter designed for this purpose was used at Bangalore (12°58′N, 77°35′E) to investigate the pulse characteristics of noise bursts at 3 MHz with a receiver bandwidth of 3.3 kHz/6dB. The results show that the number of pulses lying in the amplitude range between peak and quasi-peak values of the noise bursts and the burst duration corresponding to these pulses follow log normal distributions. The pulse rates deduced therefrom show certain correlation between the number of pulses and the duration of the noise burst. The results are discussed with a view to furnish necessary information for data communication. (auth)

58877 UPWARD-MOVING IRREGULARITIES IN THE SUB-EQUATORIAL IONOSPHERE. **Faynot, J. M.; Vila, P.; Walter, J. (GRI–CNET, Issy-les-Moulineaux, France). J. Atmos. Terrest. Phys.; 33: No. 10, 1621-7(Oct 1971).**

Upward-rising equatorial strata, differing from other h′(f) structures, are described. The rising motion, analyzed by N(h) profiles, can be explained at F2-region levels by Hall drift from the daytime west–east electric field. Day-to-day and seasonal variations are discussed. (auth)

58878 HEIGHT AND FREQUENCY VARIATION OF PENETRATING AND NON-PENETRATING MODES IN THE IONOSPHERE. **Altman, C.; Postan, A. (Technion–Israel Inst. of Tech., Haifa). J. Atmos. Terrest. Phys.; 33: No. 10, 1629-39 (Oct 1971).**

A thin-film optical method is adapted to determine the full-wave reflection and transmission coefficients, R_p, R_{np}, τ_p and τ_{np} of the "penetrating" and "non-penetrating" modes vertically incident from below on a horizontal ionospheric slab whose base is the bottom of the ionosphere and which follows the given variation of the ionospheric parameters up to the top of the slab, above which it passes continuously into a homogeneous semi-infinite medium. The thin-film optical method is based on the iterative variation of the height, h, of the top of the slab, and the technique thus yields the full-wave reflection and transmission coefficients as functions of the height, h, of the upper slab-face. The wave polarizations of the incident penetrating and non-penetrating modes are such as to yield maximum and minimum energy transmission respectively, high in the ionosphere. For frequencies less than the critical coupling frequency or somewhat above it it was found, for the total ionosphere, that $R_{np} > R_p$, almost the entire contribution to both the reflection coefficients coming from the $X = 1 + Y$ level. For frequencies very much greater than the critical coupling frequency, however, the behavior of the reflection coefficients is more complex. When the height of the upper slab-face is just above the $X = 1$ level, $R_{np} > R_p$, whereas for the total ionosphere, i.e., for heights extending beyond the $X = 1 + Y$ level, $R_p > R_{np}$. The unexpected result is explained in terms of the behavior of the characteristic waves composing the penetrating and non-penetrating modes. (auth)

58879 SEMIANNUAL VARIATION IN HEIGHT OF F2-LAYER PEAK. **Eccles, D.; King, J. W.; Kohl, H.; Pratt, R. J. (Radio and Space Research Station, Slough, Eng.). J. Atmos. Terrest. Phys.; 33: No. 10, 1641-6(Oct 1971).**

Noon values of h_mF2 were calculated for two midlatitude stations for the fifteenth day of each month in 1958. The theoretical variations of the layer height during the year are found to be similar to those observed only when the semiannual variation of exospheric temperature and the effects of neutral-air winds are taken into account in the calculations. The calculated and observed f_0F2 variations are, however, completely different, indicating that some mechanism exists which exerts a controlling influence on the electron concentrations without seriously affecting the height of the layer peak. (auth)

58880 REGULAR AND IRREGULAR BEHAVIOUR OF THE WINTER ANOMALY IN IONOSPHERIC ABSORPTION. **Schwentek, H. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). J. Atmos. Terrest. Phys.; 33: No. 10, 1647-50(Oct 1971).**

It is demonstrated that in winter, at middle latitudes, three different types of absorption occur. On few days, absorption is as small as in summer. Secondly, there are a considerable number of days on which absorption follows a regular trend, increasing from the end of September to the winter solstice, then decreasing until the end of March. Finally, there are a greater number of groups of days, and also of single days, on which absorption is very high. These groups of days of excessive absorption appear sporadically, that is, at times different from winter to winter. (auth)

58881 MEASUREMENT OF THE THICKNESS OF A SPORADIC-E LAYER. **Kantarizis, E. (Univ. of Queensland, Brisbane). J. Atmos. Terrest. Phys.; 33: No. 10, 1651-6(Oct 1971).**

A method is described for measuring the thickness of a sporadic E layer from records obtained when using a phase ionosonde. The method involves the measurement of the phase advance, caused by the presence of a sporadic E layer, on echoes from the F region. One example is analyzed in detail and it was found that the sporadic E layer was a sharp-peak layer, and its thickness at a plasma frequency equal to 90% of its critical frequency was 5 km. The thickness of the same sporadic E layer was also measured independently by performing a true-height reduction, by a polynomial method, using the phase of the echoes from the E region of the ionosphere. The results obtained from the two methods were consistent. (auth)

58882 PENETRATION OF MAGNETOSHEATH PLASMA TO LOW ALTITUDES THROUGH THE DAYSIDE MAGNETOSPHERIC CUSPS. **Winningham, John David. College Station, Tex.; Texas A and M Univ. (1970). 298p. University Microfilms Order No. 71-17,849.**

Thesis.

Daytime high-latitude fluxes of low-energy (<1 keV) electrons and protons were observed with the soft-particle spectrometer on the polar satellite ISIS-I. These fluxes occur just above the limit Λ_{CL} of closed geomagnetic field lines in the dayside magnetosphere. The boundary, Λ_{CL}, can be identified through a sharp decrease in the flux of electrons of somewhat higher energy (~10 keV). The electron energy spectrum shows a sharp peak at about 100 to 200 eV, with a total flux of the order of 10^9 electrons cm^{-1} $ster^{-1}$ sec^{-1} carrying an energy of a few tenths of an erg cm^{-2} $ster^{-1}$ sec^{-1}. The electron and proton spectral shapes are shown to be similar to those in the magnetosheath and, for protons, the absolute intensities are approximately equal (no absolute intensities could be found in the literature for electrons). The proton spectrum peaks at a slightly higher energy (~300 eV) again in agreement with magnetosheath observations. The proton flux is typically $>10^7$ cm^{-2} $ster^{-1}$ sec^{-1} with typical energy fluxes in the range 0.01 to 0.1 ergs cm^{-2} $ster^{-1}$ sec^{-1}. It is concluded that solar-wind plasma can penetrate to low altitudes through the high-latitude cusp in the magnetopause, often referred to as the neutral point. (Diss. Abstr. Int., B)

58883 SPECTROPHOTOMETRY OF THE NIGHT AIRGLOW AND THE AURORAE. **Sivjee, Gulamabas Gulamhusen. Baltimore; Johns Hopkins Univ. (1970). 216p. University Microfilms Order No. 71-16,749.**

Thesis.

Spectrophotometric studies of the nightglow and auroral emissions were carried out aboard NASA's jet aircraft CV 990, the "Galileo," from Jan.–Mar. 1968 and again in Nov.–Dec. 1969. To complement the airborne experiments, ground-based measurements of the nightglow OH rotational temperature were made at Laurel Observatory in Pennsylvania during June–Dec. 1968 and Howard County in Maryland between June–Oct. 1969. A one-meter Ebert spectrometer and a five-channel photometer were employed. The nightglow OH data has revealed (a) local time variation in OH rotational-temperature and intensity, (b) latitude and seasonal variations in OH rotational-temperature, (c) covariation between the intensities of OH and 5577, (d) an occasional, preferential enhancement of OH rotational levels with rotational quantum numbers greater than 4, (e) covariation between intensities of OH and Herzberg I bands of O_2, and (f) the absence of any auroral enhancement in OH emissions. The OH intensity has also been found to be independent of H_α and 6300 radiations. The auroral data have shown that the red bands of $N_2$1PG in type-B aurora are formed by electron excitation. A study of intensity ratio of the (0–1) and (1–2) bands of the N_2^+ first negative bands as a probe for low energy protons in auroras is presented. (TSS) (Diss. Abstr. Int., B)

58884 DISTRIBUTION OF NIGHTTIME F-REGION MOLECULAR ION CONCENTRATIONS AND 6300 A NIGHTGLOW MORPHOLOGY. **Brasher, William Ernest. Denton, Tex.; North Texas State Univ. (1970). 97p. University Microfilms Order No. 71-18,649.**

Thesis.

Spatial and temporal distributions of molecular ions in the nighttime F-region of the ionosphere and the morphology of the associated 6300-Å nightglow are investigated. Ionospheric and nightglow models are developed for calculating the dominant ion concentration profiles and nightglow intensities. A numerical technique is employed in solving the coupled, nonlinear system of equations for the O^+, NO^+, and O_2^+ number densities in the nighttime F-region, including the effects of diffusion, electromagnetic

XUM

drift, minor neutral constituents, and neutral air motions. The dependence of the molecular ion profiles on the various ionospheric and atmospheric parameters that affect their distributions is determined. The correlation of specific ionospheric parameters with 6300-Å nightglow intensity during periods of magnetically quiet and disturbed conditions is demonstrated. The solutions to the ion concentration equations are compared with two types of ionospheric observations: (1) midlatitude mass spectrometer observations of the nighttime ion profiles at White Sands, New Mexico; and (2) the inter-tropical 6300-Å nightglow morphology observed at Tamanrasset, Africa. (TSS) (Diss. Abstr. Int., B)

58885 POSSIBILITY OF USING A QUADRUPOLE PROBE FOR MEASURING ELECTRIC CURRENTS IN THE MAGNETOSPHERE. **Storey, O.; Pottelette, R. (Centre National de la Recherche Scientifique, Saint-Maur-des-Fosses, France). Compt. Rend., Ser. B; 273: No. 2, 101-4(12 Jul 1971). (In French).**

The transfer impedance of a quadrupole probe is affected by its motion with respect to the plasma. This effect was studied on one of the oblique resonances of the transfer impedance. The results show that it is possible to measure the velocity of the thermal flux parallel to the magnetic field in the magnetosphere, and therefore obtain the value of the electron current. (France)

58886 INTERPLANETARY MEDIUM AND ITS INTERACTION WITH THE EARTH'S MAGNETOSPHERE. **Kovalevskii, I. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Space Sci. Rev.; 12: No. 2, 187-257(Jun 1971).**

The principal results of direct measurements of the plasma and magnetic field by spacecraft close to the Earth (within the heliocentric distance range 0.7 to 1.5 AU) are reviewed. An interpretation is given of the results for periods of decrease, minimum, and increase of the solar activity. The following problems are discussed: the interplanetary plasma (chemical composition, density, solar-wind flow speed, temperature, and temporal and spatial variation of these parameters); the interplanetary magnetic field (intensity, direction, fluctuations, and its origin); some derived parameters characterizing the physical condition of the interplanetary medium; the quasi-stationary sector structure and its relation with solar and terrestrial phenomena; the magnetohydrodynamic discontinuities in the interplanetary medium (tangential discontinuities and collisionless shock waves); the solar magnetoplasma interaction with the geomagnetic field (the collisionless bow shock wave, the magnetosheath, the magnetopause, the Earth's magnetic tail, and the internal magnetosphere characteristics); the relation between the geomagnetic activity and the interplanetary medium and magnetosphere parameters; peculiarities in behavior of the interplanetary medium and magnetosphere during geomagnetic storms; and energetic aspects of the geomagnetic storms. (auth)

58887 EFFECTS OF MAGNETIC STORMS ON ELECTRIC POWER SYSTEMS. **Tripathy, Sarat Chandra. Minneapolis; Univ. of Minnesota (1970). 149p. University Microfilms Order No. 71-18,829.**
Thesis.

Geomagnetic disturbances causing operating problems on electric power systems such as voltage fluctuations and large reactive flow are primarily due to the fact that geomagnetic disturbances produce an induced Earth surface potential, which in turn produces spurious currents in long lines and equipment that are in some way grounded. With the trend toward longer lines and interconnected power systems over large geographical areas of the country, some of the problems caused by geomagnetic disturbances have become more acute. The induced Earth surface potential (ESP) has been statistically correlated with K index, which defines the intensity of the magnetic storms. The solar induced currents (SIC) flow through the phase windings of 3-phase power transformers and give a dc bias to the core flux in the transformers causing saturation on half-cycles of the ac wave. The consequences of this saturation are variations in voltage, watt, and var flow on the system, localized internal heating in the transformer, and generation of harmonics. The effects of core saturation of power transformers were studied. In searching for likely methods of mitigation of SIC, one possibility appears to be the insertion of a nonlinear resistance element, such as thyrite in the transformer neutral. Ideally, such an element inserted in the neutral should (1) limit the SIC and (2) keep the system voltage at reasonable levels under fault conditions. The connection of thyrite in the neutral of power transformer will cause undesirable voltage transients under fault and switching conditions. (TSS) (Diss. Abstr. Int., B)

58888 CORRELATIONS BETWEEN SUDDEN PHASE ANOMALIES IN VERY LONG WAVES AND BURSTS OF SOLAR X RAYS. **Kimpara, Atsushi; Nishiwaki, Akira. Compt. Rend., Ser. B: 272: No. 26, 1493-5(28 Jun 1971). (In French).**

A severe world ionospheric storm was observed on Mar. 8, 1970 during a world geophysical period. Sudden phase anomalies (SPA) and sudden enhancements of the field (SEF) associated with signals from the Australian Northwest Cape emitter (223 Hz) were observed over a long period of time. In particular, the characteristics of the phase anomalies occurring during this period were examined. (France)

58889 UNIFORM ELECTRICAL CONDUCTIVITY MODEL FOR THE EARTH AND THE GEOMAGNETIC DISTURBANCE DAILY VARIATION. **Petersons, H. F. (Australian National Univ., Canberra). Aust. J. Phys.; 24: 593-600(Aug 1971).**

Chapman's uniform conducting core model has been investigated using S_q and SD results for the IGY. Values for the conductivity and core radius could not be found for which there was agreement between the S_q and SD results at the likely 95% confidence limit of S_q and, consequently, either the uniform core model is inadequate for representing S_q and SD or the errors in the analysis of S_q and SD are larger than estimated statistically. In the latter case a value for the conductivity σ of 1.5×10^{-12} emu and for q of 0.99 (where q is the ratio of the radius of the core to that of the Earth) would then be indicated. (auth)

58890 MEASUREMENTS OF RADIATION-BELT PROTONS IN THE ENERGY RANGE 0.25 TO 1.65 MeV ON BOARD THE SATELLITE AZUR. **Moritz, J. (Christian-Albrechts Univ., Kiel). Z. Geophys.; 37: 179-94(1971). (In German).**

Directional proton intensities in the energy range 0.25 to 1.65 MeV are measured with an experiment on board the satellite Azur (1969–97A). A telescope with two solid-state detectors of equal size, 7 mm in diameter and 34-micron thick, is used. The associated electronics allows for energy discrimination at 0.25, 0.5, 1.0, and 1.65 MeV in the total energy range of 0.25 to 13.5 MeV. The directionality is defined by a mechanical aperture that incorporates a broom magnet to suppress low-energy electrons. Direct interpretation of the count rates as particle intensities is possible only at L values greater than 1.9 and gives good agreement with earlier measurements. Within the inner radiation belt ($L < 1.9$) the count rates have to be corrected for a background due to higher-energy protons and electrons whose magnitude can be derived from the count rate of one of the detectors. The count-rate correction leads to low proton intensities within the inner radiation belt and a rising energy spectrum in the energy range 0.25 to 1.65 MeV. (auth)

58891 PROTON MEASUREMENTS IN THE MORNING SECTOR OF THE AURORAL ZONE DURING SLOWLY VARYING COSMIC NOISE ABSORPTION. **Raethjen, H. (Univ., Kiel). Z. Geophys.; 37: 195-210(1971). (In German).**

Two rockets were launched from Andenes, Norway and the energy spectrum of incoming protons was directly measured on board these rockets up to > 200 km. The differential spectrum in the energy range 130 to 450 keV can approximately be represented by the exponential law $d\Phi = \Phi_0 \exp(-E/E_0)dE$. E_0 changed from 80 to 50 keV as the absorption decreased from 2.6 to 1.7 db. The maximum integral intensity for $E > 135$ keV was 4×10^3 p/cm^{2}sec ster for 2.6 db absorption. The intensity was by a factor of 10 smaller when the absorption had decreased to the almost quiet-time level. No significant anisotropy could be observed within the small pitch-angle area included. (auth)

58892 SOLAR PARTICLE EVENT OF MARCH 1970 AS OBSERVED OVER THE POLAR CAP AND IN THE RADIATION BELT WITH THE SATELLITE GRS-A/AZUR. **Achtermann, E.; Haeusler, B.; Hovestadt, D.; Scholer, M. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Z. Geophys.; 37: 211-23(1971).**

Experimental results on energetic electrons, protons, and alpha particles are presented for the March 1970 solar particle events. The data were obtained on board the polar orbiting satellite GRS-A/AZUR by two particle telescopes for protons and alpha particles and two omnidirectional detectors for electrons and protons. The energy ranges are 1.5 to 104 MeV for protons, 6 to 19 MeV for alpha particles, and $E > 1.5$ MeV and $E > 4$ MeV for electrons. The time history of the solar particle event, the proton-to-alpha ratio, and its variation during the event, the occurrence of delayed penetration of particles into the central polar cap region, and the apparent inward motion of outer-belt electrons associated with the event are discussed. (auth)

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58893 ISSLEDOVANIYA ATMOSFERY I IONOSFERY V PERIOD POVYSHENNOI SOLNECHNOI AKTIVNOSTI (MART-APREL' 1969 g.). SBORNIK STATEI. (Studies of Atmosphere and Ionosphere at Times of Unusual Solar Activity (March-April 1969). Collection of Articles). Mikhnevich, V. V.; Danilov, A. D. (eds.). Leningrad; Gidrometeorologicheskoe Izdatel'stvo (1970). 160p.

The measurements of atmospheric and ionospheric characteristics by rockets and radio soundings in periods of vigorous solar activity during March–April, 1969, are collected and reviewed by a number of authors. Ground-level measurements are included. Correlations between solar activity, corpuscular currents, atmospheric ionization, and the structures of the upper and lower atmospheres of the Earth are made. (K.S.W.)

58894 RECENT DEVELOPMENTS IN THEORY OF SOLAR WIND. Parker, E. N. (Univ. of Chicago). Rev. Geophys. Space Phys.; 9: No. 3, 825-35(Aug 1971).

Current problems and developments in the theory of the large-scale expansion of the solar corona are reviewed. The outstanding question is whether the energy supply to the quiet corona is mainly thermal conduction outward from a region of active heating at its base or mainly wave propagation outward from the base. It is suggested that the question can be settled only when the properties of the wind can be sampled over a wide range of radial distance from the Sun, from far inside the orbit of Earth to well beyond. It has been suggested that hydromagnetic waves may drive the expansion of the active corona by direct transfer of momentum as well as energy. 72 references. (auth)

58895 PLASMA INSTABILITIES IN THE MAGNETOSPHERE. Hasegawa, Akira (Bell Telephone Labs., Inc., Murray Hill, N. J.). Rev. Geophys. Space Phys.; 9: No. 3, 703-72(Aug 1971).

An introductory review of theories of plasma instabilities in the magnetosphere is presented. Part A is a review of theories of plasma instabilities that are relevant to magnetospheric plasmas. Instabilities arising from velocity-distribution anisotropies, such as a pitch-angle anisotropy or the presence of beams, as well as instabilities from nonuniform distributions of plasmas and magnetic fields, are discussed. Particular emphasis is placed on the effect of a mixture of a cold plasma in a high-β plasma. Part B is a summary of works related to actual plasma instabilities in the magnetosphere. In view of the observed plasma parameters, it is shown that the magnetosphere is rather stable against most macroscopic instabilities, and its dynamics are predominantly governed by microscopic instabilities. 132 references. (auth)

58896 PATTERNS AND SOURCES OF HIGH-LATITUDE PARTICLE PRECIPITATION. Paulikas, G. A. (Aerospace Corp., El Segundo, Calif.). Rev. Geophys. Space Phys.; 9: No. 3, 659-701(Aug 1971).

The zones of particles precipitated into high latitudes from the outer magnetosphere are studied to associate source regions, and, if possible, precipitation mechanisms with each of the families of precipitating particles that collectively form the auroral zone. The precipitation patterns for both electrons and protons exhibit a diurnal variation. The several zones of particle precipitation can be placed in relationship to each other. The zone of electron precipitation is best described as consisting of a region at low latitudes ($60° \lesssim \Lambda \lesssim 70°$ near local midnight) where electrons with characteristic energies of tens of keV precipitate; this region merges and overlaps at the higher latitudes with another region ($70° \lesssim \Lambda \lesssim 80°$ near local midnight) characterized by precipitating electrons of ≈ 0.5 keV. The limited data available indicate that the zone of proton precipitation spatially overlaps the zone of electron precipitation. Near local noon a separate region of very soft proton precipitation is found in the vicinity of $\Lambda \approx 80°$, in addition to a region of proton influx at lower latitudes. The plasma sheet, the extraterrestrial ring current, the polar cusp, and the outer radiation belt are considered as source regions of precipitating particles. Brief surveys of the precipitation of helium ions and of possible means of artificially inducing particle precipitation are also included. 133 references. (auth)

58897 ENERGETIC ELECTRON PRECIPITATION NEAR THE PLASMAPAUSE. Rosenberg, T. J. (Univ. of Maryland, College Park). Antarctic J. U. S.; 6: No. 4, 131(Jul-Aug 1971).

Bremsstrahlung x radiation was measured at Siple Station during the 1970–1971 austral summer to study energetic electron precipitation from the magnetosphere. The degree of correlation was determined between energetic electron precipitation as manifested by bremsstrahlung x rays at balloon heights and various types of vlf emissions recorded by ground-based receivers. The plasmapause is a region of enhanced wave activity and a likely area to find a high degree of correlation between temporal features in electron precipitation and vlf noise. The equatorward extent of electron precipitation events associated with magnetic storms and substorms was examined to determine if it coincides with the position of the plasmapause. It was found that short duration bursts of x rays with energies greater than 30 keV were correlated one-to-one with discrete vlf rising tones in the 1.5- to 4.5-k Hz band and perhaps represent the first experimental evidence for an electron precipitation effect related to cyclotron resonance on magnetospheric-field lines. (J.C.W.)

58898 CONJUGATE GEOMAGNETIC STUDIES NEAR THE PLASMAPAUSE. Lanzerotti, L. J.; Lie, H. P.; Tartaglia, N. A. (Bell Telephone Labs., Murray Hill, N. J.). Antarctic J. U. S.; 6: No. 4, 129-31(Jul-Aug 1971).

The study of the conjugate magnetic field near the average plasmapause position will extend the magnetic bay studies of Boyd (1963) and the single-axis measurements of Campbell (1968). Present measurements were taken at Siple Station, Antarctica, and at three stations spaced at 70-km intervals on the north–south line in Quebec. Naturally occurring geomagnetic noise and coherent pulsations were analyzed. Data were analyzed following the large geomagnetic storm of Dec. 14, 1970. The dynamic power spectral analysis of the H-component shows no coherent pulsations during the observation on Dec. 15 and could be due to low plasma densities outside the plasmapause following the large storm. The observed reappearance of pulsations on later days suggests a filling of the plasmasphere, as observed in whistler measurements (Park, 1970). An observed similarity exists at all stations and the observed magnetic noise near conjugate locations in both hemispheres indicates a magnetospheric, rather than ionospheric, origin for the noise. (J.C.W.)

58899 INVESTIGATION OF THE IONOSPHERIC D REGION AT SUNRISE. Turco, Richard Peter Urbana, Ill.; Univ. of Illinois (1971). 295p. University Microfilms Order No. 71-21,255.

Thesis.

The growth over sunrise of the C and D layers of the ionosphere are investigated. The model which is analyzed includes the negative ion species O^-, O_2^-, O_3^-, O_4^-, NO_2^-, NO_3^-, CO_3^-, and CO_4^-; ionization sources due to galactic cosmic rays, precipitated electrons, ionization of NO by scattered Lyman-α radiation, and the direct solar-radiation ionization of NO and $O_2(^1\Delta g)$; the photodetachment of most of the negative ions; and the time variation of all of these parameters. Also calculated are the detailed sunrise behaviors of the neutral atmospheric species O, O_3, and $O_2(^1\Delta g)$. The time variations of the electron, negative ion, and positive ion densities are calculated over sunrise. From these data the mesospheric C- and D-layer development is plotted. Several model parameters are varied until the best agreement with experimentally determined electron densities is obtained. The results are discussed in light of several atmospheric parameters including the O and NO concentrations and the electron–ion recombination coefficient. (Diss. Abstr. Int, B)

58900 ELECTROSTATIC PLASMA INSTABILITIES IN THE EQUATORIAL ELECTROJET. Prakash, S.; Gupta, S. P.; Subbaraya, B. H.; Jain, C. L. (Physical Research Lab., Ahmedabad, India). Nature (London) Phys. Sci.; 233: No. 38, 56-8(20 Sep 1971).

It is stated that, during the flights of two Nike Apache rockets launched from Thumba, India on Jan. 28, 1971 and carrying Langmuir probes and other aeronomy payloads, large- and small-scale irregularities in electron density were observed. Above 100 km the amplitude of the large-scale irregularities decreased, whereas the opposite was the case for the small-scale irregularities. Results are given for the small-scale irregularities of scale sizes 1 to 15 m in the 87- to 98-km region. Spectral indices are shown graphically, and mechanisms are discussed. It appears that another mechanism may have been operating simultaneously with cross-field instability, and in this connection, electrostatic plasma instabilities in the equatorial electrojet are discussed. Simultaneous measurements of electrojet currents could not be made, but extrapolated values from another flight are used in the discussion. The amplitude of irregularities in the 105-km region correlated well with the intensity of the electrojet currents. (UK)

58901 SIMULTANEOUS SUDDEN FREQUENCY DEVIATIONS AND SUDDEN ENHANCEMENTS OF THE TOTAL ELECTRON CONTENT OF THE IONOSPHERE. Papagiannis, M. D.; Matsoukas, D. A. (Boston Univ.). Nature (London) Phys. Sci.; 233: No. 38, 55-6(20 Sep 1971).

A direct comparison is reported between sudden increases of the total electron content (SITEC) of the ionosphere during solar-flare events and sudden frequency deviations (SFD). The SITEC data were obtained at the Sagamore Hill AFCRL radio observatory,

XUM

using the vhf signals of the ATS-3 and -5 geostationary satellites, and the SFD data were recorded at Boulder, Colorado. Analysis was performed for the period Jan. 1969 to July 1970. It was found that the probability of an SFD accompanying a simultaneous SITEC increased rapidly with increasing peak frequency deviation. Also investigated was the time correspondence of SFD and SITEC events; the rise time from start to maximum was found to be nearly the same (~2 min) for both. The time of the peak frequency deviation appeared to coincide with the time of the maximum rate of change in TEC (total electron content). The chief contribution to the enhanced TEC appears to be produced in the F1 and F2 regions. The results suggest that both SITEC and SFD phenomena are manifestations of enhanced ionization produced by the same euv-flare emission in the same region of the ionosphere. (UK)

58902 STUDY OF THE (4-1) AND (5-2) HYDROXYL BANDS IN THE NIGHT AIRGLOW. **Harrison, A. W. (Univ. of Calgary, Alberta); Evans, W. F. J.; Llewellyn, E. J. Can. J. Phys.; 49: No. 19, 2509-17(1 Oct 1971).**

A one-year study of the (4−1) and (5−2) hydroxyl bands in the night airglow near 1 μ revealed a nonuniform rotational temperature across the P branch of each band. The temperature increases with K' value. There is a pronounced seasonal variation of temperature showing a summer minimum and winter maximum. The average measured brightness for the (4−1) band is 4.6 kR (winter) and 3.5 kR (summer), and for the (5−2) band is 5.8 kR (winter) and 4.3 kR (summer). It is shown that the time-averaged total band intensity fluctuations during a single night are quite large, sometimes a factor of 2, and are not definitely correlated with the rotational temperature during the same period. (auth) (Canada)

58903 SOME CHARACTERISTICS OF IRREGULAR MICROPULSATIONS Pi2 AT HIGH-LATITUDE STATIONS. **Gupta, Jagdish C.; Stening, Robert J. (Dept. of Energy, Mines, and Resources, Ottawa). Can. J. Phys.; 49: No. 18, 2338-49(15 Sep 1971).**

Pi2 micropulsations were studied for the period July 12 to August 16, 1968, from four observatories at different latitudes in Canada. Maximum occurrence was near midnight with a preference for 5−6 hr UT at all longitudes studied. The relationship of Pi2 occurrence to magnetic bays and to Kp is examined. The correlation of Pi amplitudes and periods with Kp and other parameters reveals a different pattern for lower-latitude stations (Ottawa and Meanook) compared with Baker Lake (73.9°N). These results are interpreted as evidence for two different types of Pi in the different-latitude regions, the lower latitude Pi being associated with hydromagnetic waves on the plasmapause. In studies of simultaneous Pi events at the four stations, the maximum amplitude occurred most frequently at Meanook. Polarization of such events was found to be different at different stations, therefore previously reported patterns of Pi polarization could not be confirmed. (auth) (Canada)

58904 PITCH-ANGLE DISTRIBUTION OF FAST ELECTRONS. **Miyazaki, Yukio; Takeuchi, Hajime; Imai, Takashi; Watanabe, Setsuko (Inst. of Physical and Chemical Research, Wako, Japan). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku; 7: No. 1, 133-44(Mar 1971). (In Japanese).**

Local pitch-angle distribution of electrons was measured in a region lower than the radiation belt at low latitude. Results show that the electrons were captured by lines of magnetic force with considerably acute pitch angle at altitude from 350 to 1200 km. If $\sin^n \alpha$ is assumed for the distribution, the exponent n is 10 or more. Intensity of high-energy electrons (≳500 keV) showed longitudinal effect of factor 2 at 140 and at 160°E, and the distribution at 160°E was more flat. Comparison was made at altitude of 1000 km. Differential energy spectra in the range of 100 to 500 keV is proposed as about $E^{-2.75}$ at an altitude from 800 to 1200 km. (Japan)

58905 EFFECT OF MAGNETIC ACTIVITY ON ELECTRON DRIFTS IN EQUATORIAL ELECTROJET REGION. **Rastogi, R. G.; Chandra, H.; Misra, R. K. (Physical Research Lab., Ahmedabad, India). Nature (London) Phys. Sci.; 233: No. 36, 13-15(Sep 1971).**

Studies are described of the variations of electron-drift speed with magnetic activity at Thumba, near the magnetic equator and histograms are shown for the apparent drift speed in the E and F regions on five international quiet and five international disturbed days during 1964 and 1967−1968. In all cases the histograms are displaced towards lower drift values for disturbed days, and the drifts over the magnetic equator decrease with increased magnetic activity both for day and night hours. The E-region electron density being larger by a factor of about 100 during the day, the changes in drift speed would affect the electrojet currents and thereby the magnetic field at ground level mainly during the daytime hours. The total electrostatic field at low latitudes could decrease with increasing magnetic activity, explaining the decrease of electron drift with magnetic activity at low latitudes. (UK)

58906 UNSTABLE RADIATION ZONE: REGION WHERE AURORAL AND SEMITRAPPED PARTICLES ARE TRAPPED. **Troshichev, O. A. Cosmic Res. (USSR) (Engl. Transl.): 8: No. 6, 836-41(Nov-Dec 1970).**

Translated from Kosm. Issled.; 8: No. 6, 915-22(Nov-Dec 1970).

The distribution of charged particles in the magnetosphere beyond the radiation belts is examined. The concept of an unstable radiation zone, i.e., a special region containing auroral and semitrapped particles, is advanced and developed. It is shown that the space−time distribution pattern of auroral and magneto-ionospheric disturbances at high latitudes is governed by the specific features of the particle distribution in this unstable radiation zone. (auth)

58907 NONADIABATIC BEHAVIOR OF RADIATION-BELT PARTICLES. **Taylor, Harold E. (Princeton Univ., N. J.); Hastie, R. J. Cosmic Electrodyn.; 2: No. 2, 211-23(Jul 1971).**

The boundary of the trapping region is observed to be at lower latitudes for higher-rigidity particles, a type of inverse Stormer effect. This effect is studied for particles having large mirror ratios by numerically tracing particle orbits and investigating nonadiabatic jumps in the first invariant. Analytical expressions for these jumps are obtained for a dipole field, and a useful condition necessary for adiabaticity is obtained and applied to a more realistic model of the geomagnetic field. The numerical techniques applied to this realistic model predict the spatial profile and rigidity dependence of the boundary of the trapping region in the midnight meridian. The predicted boundary falls midway between the observed low-latitude cutoff of cosmic rays and the observed high-latitude boundary of the trapping region. (auth)

58908 EMPIRICAL DETERMINATION OF AERODYNAMIC FACTORS FOR THE MAGNETOSPHERE. **Schieldge, J. P.; Siscoe, G. L. (Univ. of California, Los Angeles). Cosmic Electrodyn.; 2: No. 2, 141-63(Jul 1971).**

The empirical drag coefficient, the north−south component of the lift due to the inclination of the dipole axis to the solar-wind direction, and the empirical shape of the magnetosphere were determined from satellite data associated with the five geomagnetically quiet days of each month for the first half of 1967. Twenty-eight days of Fourier-analyzed ATS-1 magnetic-field data and the averages of thirteen coincident days of Explorer 33 solar-wind data were used in the study. The magnetic-field gradient near the Earth is proportional to the solar-wind stagnation pressure. The theoretical drag coefficient agrees with the experimental result if the gradient field includes contributions from the Chapman−Ferraro currents, ring current, and tail currents. There is some evidence for a tilt-associated lift that is northward in the northern-hemisphere winter, consistent with that expected for supersonic aerodynamic flow about a smooth wing profile approximating calculated tilted dipole shapes of the magnetosphere. The empirical shape is calculated by an indirect method and corresponds reasonably well with theoretical predictions of the magnetopause geometry. Differences that occur suggest that the effective shape may be blunter because of additional wave drag and/or tangential forces on the magnetospheric tail. (auth)

58909 ELECTRIC COUPLING BETWEEN THE MAGNETOSPHERE AND THE IONOSPHERE AS A CAUSE OF POLAR MAGNETIC DISTURBANCES AND AURORAL BREAK-UP. **Oguti, Takasi (Tokyo Univ.). Cosmic Electrodyn.; 2: No. 2, 164-83(Jul 1971).**

Electric currents in the polar ionosphere are considered to be transient currents, with a characteristic time scale defined by ($C_M \cdot R_I$), the combination of a magnetospheric capacitance C_M and ionospheric Pedersen resistance R_I. This time scale is of the order of one hour for a large-scale electric current system such as the DP-2 field, and the phase lag of ionospheric currents is about 10 to 15 min behind the change in the solar wind. The mechanism of DP-2 development is interpreted as the charging of the magnetosphere, being positive on the dawn side and negative on the dusk side, and is produced by the polarization current in the solar wind. The auroral electrojet is attributed to an electric discharge along a filamental structure of auroral arcs. The discharge process is described in the following way. If any heterogeneity of conductivity appears in the polar ionosphere, it modifies

XUM

the DP-2 electric field. The modification results in a transient electric field parallel to the magnetic field. This field, in turn, can accelerate thermal particles and, accordingly, makes them precipitate. The precipitation of particles makes the heterogeneity of conductivity larger. Thus, a positive feedback loop is completed, and the precipitation and the discharge grows explosively, being associated with rapid acceleration of particles. The electric discharge lasts until the distribution of the electric field attains a new quasi-steady state. The acceleration of particles occurs between the magnetosphere and the ionosphere during the discharge process. Energetic particles, thus produced, cause the inflation of the magnetosphere and, also, are the origin of electron bursts in the magnetotail. A mechanism of the plasmapause formation is discussed in conjunction with the acceleration and precipitation of the thermal plasma in the outer magnetosphere. (auth)

58910 SOME PROCESSES IN THE MAGNETOSPHERE. Shabanskii, V. P. (Inst. of Nuclear Physics, Moscow). Space Sci. Rev.; 12: No. 3, 299-418(Jul 1971).

An earlier review of some magnetospheric processes by the author (Space Sci. Rev., 8: 366(1968)) is continued under the following headings: motion of the magnetic-field lines in plasma, electromagnetic processes in the magnetotail, and trapped-particle movement in the magnetospheric core. There are 115 references cited, 43 of which are Soviet papers. (J.C.W.)

Low-Temperature Physics and Cryogenic Equipment

Refer also to abstract 59215.

Superfluidity

Refer also to abstract 59850.

58911 SURFACE-STATE LIFETIMES AND CURRENT FLOW IN LIQUID HELIUM. Williams, R.; Crandall, R. S. (Radio Corp. of America Labs., Princeton, N. J.). Phys. Rev., A; 4: No. 5, 2024-6(Nov 1971).

The lifetime of electrons trapped at the free surface of liquid ^{4}He was determined from the temperature dependence of the current flow in the liquid. These lifetimes are in substantial agreement with the values determined directly for the liquid/gas interface in ^{4}He. New results presented for the ^{4}He/^{3}He interface give lifetimes as long as 10^5 sec. (auth)

58912 PHENOMENOLOGICAL THEORY ON CRITICAL PHENOMENA IN LIQUID HELIUM. II. Ueyama, Hiroshi (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 1, 34-41(Jul 1971).

A method proposed previously is extended to problems of anomalous attenuation of the first and second sounds below the λ-point. Both of their damping constants are shown to have the contribution of the Landau–Khalatnikov absorption and that due to fluctuations of the order parameter. The former is the same as Usui's result and the latter is symmetric around the λ point. Relations among the anomalous parts of transport coefficients above and below the λ point are clarified. (auth)

58913 COLLOQUIUM ON HELIUM AT VERY LOW TEMPERATURES, GRENOBLE, FRANCE, MARCH 23–25, 1970. J. Phys. (Paris), Colloq.; C3: No. 10, C.1-136(Oct 1970). (In French and English). (CONF-700339).

The 12 papers which introduced the various round tables are presented. The four papers concerning superfluid helium are abstracted individually. (France)

For abstracts of individual papers see: 58914–58917.

58914 TRANSPORT PROPERTIES AND PHASE COHERENCE IN SUPERFLUID HELIUM. Libchaber, A. (Ecole Normale Superieure, Paris). J. Phys. (Paris), Colloq.; C3: No. 10, C.3.5-16(Oct 1970). (In French).

From Conference on helium at very low temperatures; Grenoble, France (23 Mar 1970). See CONF-700339.

Transport properties of superfluid He under critical and subcritical flow conditions are studied. Equations of motion for the superfluid are given from two models: the hydrodynamic model, and a model associated with order parameters. The crucial experiments on permanent currents are reviewed. Superleaks and transport in liquid helium films are studied. Experiments on the Josephson–Anderson effects are analyzed. (France)

58915 HYDRODYNAMICS AND SIZE EFFECTS IN SUPERFLUID HELIUM. Guyon, E. (Paris Univ., Orsay, France). J. Phys. (Paris), Colloq.; C3: No. 10, C.3.17-27(Oct 1970). (In French).

From Conference on helium at very low temperatures; Grenoble, France (23 Mar 1970). See CONF-700339.

Two-fluid hydrodynamics is used to study waves propagated in superfluid helium. The properties of first and second sound are briefly reviewed. The properties of fourth sound, which is a temperature and density wave, are discussed for porous systems in particular cases where the normal fluid is partially unlocked. Fourth and third sound, which are surface waves in the superfluid film, give information on size effects such as superfluid density and critical velocity. These results are compared with measurements. (France)

58916 SCATTERING OF LIGHT FROM LIQUID HELIUM. Vinen, W. F.; Vaughan, J. M. (Univ. of Birmingham, Eng.). J. Phys. (Paris), Colloq.; C3: No. 10, C.3.29-38(Oct 1970).

From Conference on helium at very low temperatures; Grenoble, France (23 Mar 1970). See CONF-700339.

A review is given of the scattering of light by superfluid helium. A brief discussion is given first of the theory of Brillouin and Rayleigh scattering from an ordinary simple pure liquid. It is shown how this discussion must be modified in the case of the superfluid phase of pure ^{4}He, and experimental observations of Brillouin scattering from first sound in liquid helium are described. The discussion is extended to the case of a superfluid mixture of ^{3}He and ^{4}He, and a recent observation of Brillouin scattering from second sound in such a mixture is described. Recent work on Raman scattering from superfluid helium (two-roton production) is then discussed, and in a final section a brief review is given of the special situation that obtains in the neighborhood of the λ point. (France)

58917 IONS AND VORTICES IN ^{4}He. Gamota, G. (Bell Telephone Labs., Murray Hill, N. J.). J. Phys. (Paris), Colloq.; C3: No. 10, C.3.39-54(Oct 1970).

From Conference on helium at very low temperatures; Grenoble, France (23 Mar 1970). See CONF-700339.

Experiments carried out to investigate the properties of ions in ^{4}He are reviewed and the results obtained discussed. Theoretical ideas on quantized vorticity and rotating helium are introduced and vortex rings discussed. The interaction of ions and vortices is considered and the processes linking the creation of vortex rings with the existence of a critical velocity and a new particle, designated the neutral, are investigated. (France)

58918 EXPLICIT EXAMPLES OF OFF-DIAGONAL LONG-RANGE ORDER. Di Castro, C.; Jona-Lasinio, G. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome). pp 91-100 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

In attempting to construct a unified picture of the characteristic properties of superfluid He, the situation arises in which uncorrelated ideas of a different nature have to be invoked according to the particular problem under consideration. Those ideas which concentrate more on the thermodynamical properties and, therefore, deal mainly with macroscopic variables are considered and certain features are pointed out which, so far, have not received enough attention. (W.D.M.)

58919 HEAT CAPACITY OF LIQUID ^{4}He AND ^{3}He–^{4}He MIXTURES AT THE LAMBDA TRANSITION. Gasparini, Francis Marino. Minneapolis; Univ. of Minnesota (1970). 166p. University Microfilms Order No. 71-18,726.

Thesis.

The heat capacity of liquid ^{4}He and ^{3}He–^{4}He mixtures up to a ^{3}He concentration of 0.390 was measured with a temperature resolution of about 10^{-7}K. The measurements made with the partly filled calorimeter were shown to be equal to Cpx, the heat capacity of the liquid at constant pressure and concentration. Measurements of Cvx at two different molar volumes and $x \cong 0.30$ were also made. The data are analyzed in the context of scaling laws and the renormalization of critical exponents. (TSS) (Diss. Abstr. Int., B)

58920 COLLECTIVE MODES IN FERMI LIQUIDS. Clarke, John Stephen. Ithaca, N. Y.; Cornell Univ. (1970). 155p. University Microfilms Order No. 71-17,636.

Thesis.

As an application of the Landau theory of Fermi liquids, a simple expression for the relationship between momentum distribution parameters for any zero sound mode m, involving two parameters of the interaction A_m and A_{m+1}, was derived. The expression is

XUM

derived with the hypothesis that higher-order parameters are negligible. It can be shown from this expression, plus constraints imposed by the conservation of momentum and particles in collisions, that the m = 0 mode has very low attenuation compared to higher-order modes. Only the m = 0 mode has been observed in liquid ^{3}He, in the millidegree range of temperatures. Landau's theory, which assumes only short-range forces, has been extended by Silin to encompass the conduction electrons in a metal. This was done by introducing a self-consistent electric field. Collective oscillations due to Fermi-liquid interactions can occur in a metal, but the presence of electric fields alters the dispersion relation. As a result, such oscillations occur when the transverse conductivity is zero. It is shown that this can only occur in the presence of a strong magnetic field, because the electron–electron interaction is weak. With the assumption of specular electron reflection at the surfaces, simple expressions can be derived for the optical constants of a parallel plane metal slab. The dynamics of electron motion are represented exclusively by the conductivity. Fermi liquid corrections do not significantly alter the reflectivity or surface impedance in this model, but transmissivity is significantly enhanced in a narrow region of frequency near the cyclotron frequency, ω_c. (TSS) (Diss. Abstr. Int., B)

58921 CRITICAL VELOCITIES IN SUPERFLUID HELIUM FLOW THROUGH 10-μm-DIAMETER PINHOLES. Hess, George B. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett.; 27: No. 15, 977-9(11 Oct 1971).

The dissipation mechanism that usually limits superfluid flow to about 30 cm/sec in large pinholes is found to be suppressed by compressed-rouge superfluid filters placed in the flow path on each side of the orifice. The much larger intrinsic critical velocity is then observed for the first time in large channels. (auth)

58922 DEPENDENCE OF THE HELIUM II FILM TRANSFER RATE ON PRESSURE HEAD, FILM HEIGHT, AND SUBSTRATE. Duthler, Carl James. East Lansing, Mich.; Michigan State Univ. (1970). 90p. University Microfilms Order No. 71-18,196. Thesis.

Helium film transfer rates, σ, were measured as a function of level difference, z, and height, h to the beaker rim, for filling clean glass and neon coated beakers. Measured transfer rates as a function of level difference or pressure head are described by: $\sigma(z) = 1/[A - B(\ln z(\mathrm{cm}))]$. For T = 1.65 K and h = 7 cm, the values $A = (1.80 \pm 0.09) \times 10^4$ sec/cm^2 and $B = (8.9 \pm 1.9) \times 10^2$ sec/cm^2 are found. For T = 1.28 K and h = 7 cm, the values $A = (1.35 \pm 0.02) \times 10^4$ sec/cm^2 and $B = (8.4 \pm 1.4) \times 10^2$ sec/cm^2 are found. The dependence of the transfer rate on height is: $\sigma(h) = 10(\rho_s/\rho)h^{-(0.26\pm0.05)} \times 10^5$ cm^3/sec-cm. These observations give the dependence, $P_s \propto \exp[f(h,T)/v_s]$, of the frictional pressure, P_s which opposes the flow, on superfluid velocity, v_s. The dependence, $v_c \propto d^{-1/4}$, of the critical velocity, v_c, on film thickness, d, is also determined from these results. A 16% decrease is observed in σ going from a clean glass substrate to a neon coated substrate in the same apparatus. This result is in reasonable agreement with the calculated helium film thickness for a neon substrate of $2.3h^{-1/3} \times 10^{-6}$ cm. (Diss. Abstr. Int., B)

58923 CORE STRUCTURE OF A QUANTIZED VORTEX. Fetter, Alexander L. (Stanford Univ., Calif.). Phys. Rev. Lett.; 27: No. 15, 986-8(11 Oct 1971).

The core of a singly quantized vortex is shown to consist of both condensed and noncondensed particles. Model calculations with an imperfect Bose gas suggest a plausible core structure in liquid helium. (auth)

58924 SUM RULES FOR A BINARY SOLUTION OF EFFECTIVE INTERACTIONS BETWEEN ^{3}He QUASI PARTICLES IN SUPERFLUID ^{4}He. Tan, Hing-tat (Univ. of Minnesota, Minneapolis); Woo, Chia-wei; Wu, F. Y. Contract AT(11-1)-1569. J. Low Temp. Phys.; 5: No. 3, 261-5(Sep 1971).

Sum rules are derived for dynamic structure factors for a binary solution and applied to the Woo–Tan–Massey theory of ^{3}He–^{4}He solutions. It is demonstrated that in the long-wavelength region the effective ^{3}He quasi-particle interaction V_k contains no linear k dependence. In other words, $V_k \rightarrow A + Bk^2$, as $k \rightarrow 0$. This result is exact, and requires no empirical information. It is consistent with expressions of V_k assumed by Eckstein, Eckstein, Kuper, and Ron, and by Ebner, based on fitting experimental data such as osmotic pressure measurements. (auth)

58925 POTENTIAL-PROBE DISSIPATION MEASUREMENTS IN A FLOWING SUPERFLUID HELIUM FILM. Liebenberg, D. H. (Los Alamos Scientific Lab., N. Mex.). J. Low Temp. Phys.; 5: No. 3, 267-73(Sep 1971).

Dissipation along a thermally driven, flowing, superfluid helium film was measured using an adaptation of the Keller–Hammel potential probes. These data are described by Langer–Fisher fluctuation theory, provided the velocity dependence is characteristic of vortex ring generation. (auth)

58926 MASS AND SPIN DIFFUSION NEAR THE λ LINE IN DILUTE ^{3}He–^{4}He MIXTURES. Eggington, M. A.; Leggett, A. J. (Univ. of Sussex, Brighton, Eng.). J. Low Temp. Phys.; 5: No. 3, 275-84(Sep 1971).

The possibility of using NMR and other measurements on very weak solutions of ^{3}He in liquid ^{4}He to investigate the superfluid phase transition is examined. It is found that even for these very weak solutions the mass (D_m) and spin (D_s) diffusion coefficients associated with the ^{3}He behave in radically different ways: D_m is predicted to diverge as T approaches T_λ from above as $(T - T_\lambda)^{-1/3}$, while the behavior of D_s depends on the type of experiment, and for the ordinary spin–echo type, has no particular singularity. (auth)

58927 FLOW DISSIPATION EQUATION IN LIQUID HELIUM II. Chester, Marvin; Ziff, Robert (Univ. of California, Los Angeles). J. Low Temp. Phys.; 5: No. 3, 285-311(Sep 1971).

At high flow rates superfluid helium exhibits dissipation in that a chemical potential gradient is necessary to drive the flow. On the basis of a specific model for the cause of this behavior, a detailed relationship between the chemical potential gradient and the resultant flow is derived. Some implications of the theory with regard to recent experiments are discussed. (auth)

Superconductivity

Refer also to abstract 58272.

58928 (CALT-822-37) OCCURRENCE OF SUPERCONDUCTIVITY IN SIMPLE CUBIC $(Au_{1-x}Pd_x)Te_2$ ALLOYS. Chen, Wilkie Y. K.; Tsuei, C. C. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Oct 1971. Contract AT(04-3)-822. 9p. Dep. NTIS.

The superconducting transition temperatures and lattice parameters of metastable simple cubic alloys $(Au_{1-x}Pd_x)Te_2$, with $0 \leq x \leq 0.6$, obtained by rapid quenching from liquid state, were measured as a function of x. As x increases, the transition temperature T_C goes through a minimum of 1.6°K near x = 0.05 and then increases steadily to a maximum of 4.5°K at x = 0.45. The lattice parameter shows a slight linear decrease as x increases. Transverse magnetoresistance for the composition x = 0.2 saturates at relatively low field (~2 kG) and is unusually large (~0.14). The initial depression of T_C with increasing Pd content can be interpreted in terms of the information obtained in a previous study of binary Au–Te alloys. The unusual increase of T_C with further increase in Pd concentration is not well understood. (auth)

58929 (FRNC-TH-72) MEASUREMENT DEVICE AND NUMERICAL ANALYSIS OF ELECTRICAL RESISTIVITY FROM 4 TO 300°K. APPLICATION TO NIOBIUM–HAFNIUM ALLOYS. Teixeira, J. M. (Grenoble Univ. (France). Faculte des Sciences). 1970. 116p. (In French). Dep. NTIS (U. S. Sales Only). Thesis.

Niobium–hafnium alloys were studied from the point of view of superconductivity by making measurements at different temperatures. In this way an apparatus was developed, which uses only one cryogenic liquid and is capable of measurements between 4 and 300°K. Measurements made on a great number of samples with different concentrations and heat treatments allowed the critical temperatures and changes in parameters of the Bloch–Wilson theory to be determined. Identical resistivity laws were obtained for the strain-hardened or annealed Nb–Hf samples. (France)

58930 HIGHER ORDER EFFECTS DUE TO SUPERCONDUCTING FLUCTUATION ON ELECTRICAL CONDUCTIVITY. Takayama, Hajime (Tokyo Univ.); Maki, Kazumi. Progr. Theor. Phys. (Kyoto); 46: No. 1, 42-62(Jul 1971).

Higher-order corrections to electrical conductivity due to the fluctuation of the superconducting order parameter in the paraconducting region are studied systematically. Use is made of a perturbation expansion in powers of independent fluctuations. When $\delta \gg \epsilon_0$, where δ is a pair-breaking energy and $\epsilon_0 (= (8/\pi)(T - T_c))$ is the relaxation rate of the order parameter, it is shown that the deviation from the mean field theory can be described by use of the renormalized fluctuation propagator, consistent with the idea of the dynamical scaling theory. When $\delta \ll \epsilon_0$, on the other hand, the conductivity diverges more strongly than that expected from the analysis of the static properties and, in this case, the above idea appears not to be applicable. In particular, the most divergent series are summed up for small δ, and it is shown that the anomalous term still diverges but with a weaker δ^{-1} dependence. Fluctuation effects on other transport coefficients are also studied. (auth)

58931 SURFACE SECOND SOUND IN LIQUID HELIUM. Andreev, A. F.; Kompaneets, D. A. (Inst. of Physics Problems, Moscow). JETP Lett. (USSR) (Engl. Transl.); 13: No. 12, 511-14(20 Jun 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 12, 720-4(20 Jun 1971).

Capillary waves can propagate over the surface of liquid helium, and in the superfluid solution ^{3}He in ^{4}He, there exist also surface impurity levels. Both can be regarded as surface elementary excitations. Their motion is accompanied by transport of mass, energy, entropy, etc., and it can be regarded as a motion of a surface normal component. The surface normal density is calculated in analogy with the volume case, and by substituting in the equation obtained the spectrum of capillary waves and the Planck function, the surface normal density of pure ^{4}He is obtained. It is noted that the spectrum of the capillary waves does not satisfy the Landau superfluidity criterion. If, however, the finite nature of the force of gravity is taken into consideration, then the critical velocity turns out to be finite. The oscillations of a plane free surface are considered, with allowance for the surface normal component. The system of equations describes two types of oscillations. Oscillations of the first type are ordinary capillary waves. Oscillations of the second type are analogous to volume second sound and are called surface second sound. (M.H.R.)

58932 ELECTRON DECELERATION BY DISLOCATIONS IN TYPE-II SUPERCONDUCTORS. Pustovalov, V. V.; Startsev, V. I.; Fomenko, V. S. (Physical-Technical Inst. of Low Temperatures, Kharkov). Dokl. Akad. Nauk SSSR; 196: No. 6, 1313-15(21 Feb 1971). (In Russian).

The effects of the superconducting-to-normal transition (s-n), the mixed state (s-m), and the reverse transitions (n-s and m-s) on the deforming voltage were studied in Type-II superconductors in comparison with those of Type-I (Pb, In, Tl, Sn, Hg). Tests were conducted on Pb−In alloys prepared from 99.999% pure Pb and In. Polycrystalline samples were deformed by voltage at low temperatures. The In−3.9 at. % Pb alloy, in particular, was useful in the determination of magnetization curves and thermal conductivity because this alloy exhibits Type-I superconductivity at $T > 2.25°K$, and Type II at $T < 2.25°K$. The deforming voltage behavior was a feature that differentiated Type-I and Type-II superconductors. (K.S.W.)

58933 ANOMALOUS BEHAVIOR OF THE SUPERCONDUCTING TRANSITION TEMPERATURE OF LEAD WITH A DISTORTED CRYSTAL LATTICE. Lazarev, B. G.; Semenenko, E. E.; Tutov, V. I. (Physical-Technical Inst., Kharkov). Dokl. Akad. Nauk SSSR; 196: No. 6, 1329-30(21 Feb 1971). (In Russian).

The superconducting transition temperature is generally raised by the presence of a deformed metal lattice, with a concomitant broadening of the interval of transition. Condensation of the vapor from molten lead upon a surface chilled in liquid helium provided a deformed crystalline lattice of lead in the form of a film of any desired thickness. The results of superconductivity measurement showed that a thick lead film (2,000 Å) exhibited an insignificantly small displacement of the transition temperature. In contrast, a thin (50 Å) lead film exhibited a 10% shift in the absolute temperature of transition (6.4°K instead of the 7.2°K characteristic of massive lead). Studies were made on thicknesses between the above values, and a brief discussion of their corresponding resistances is included. (K.S.W.)

58934 HIGH-TEMPERATURE SUPERCONDUCTIVITY. Ginzburg, V. L.; Kirzhnits, D. A. Vestn. Akad. Nauk SSSR; No. 5, 78-85(May 1971). (In Russian).

Advances in superconductivity from 1911 (its discovery) to the present are reviewed. With the advent of time, materials with higher critical temperatures are being discovered; thus it is predicted that T_c's of 20 to 25°C should be known within the next 20 years. Three avenues are open for search for exciton (high temperature) superconductors: metals or nonmetals (with a small number of conducting electrons), organic or polymer materials (quasi-one-dimensional chains), and plane systems (sandwich and layer compounds, quasi-two-dimensional networks). The latter is illustrated by alternate layers of TaS_2 and pyridine molecules. (K.S.W.)

58935 NON-MAGNETIC RESONANCE SCATTERING IN TWO-BAND SUPERCONDUCTORS. Kusakabe, Takashi (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 45: No. 5, 1376-81(May 1971).

The Anderson model extended to two overlapping bands is used to investigate the effect of ferromagnetic transition-metal impurities on superconductors of some transition metals due to nonmagnetic resonance scattering. The initial change in the superconducting critical temperature T_c is calculated. The results are very similar to those obtained in a previous paper, i.e., T_c is found to increase linearly with the impurity concentration for $\alpha > 1$ and, of course, to decrease linearly with the concentration for $\alpha < 1$; α is a certain parameter given by a previous paper. However, one may expect that nonmagnetic resonance scattering has a remarkably large effect as in the one-band model. The correlation effect among the localized electrons is found to be very small in comparison with the influence of nonmagnetic resonance scattering in contrast to expectations in the one-band model. Finally, it may be said that the influence of the nonmagnetic impurity scattering is very important because it reflects the more precise nature of superconductivity of some transition metals. (auth)

58936 SUPERCONDUCTING FLUCTUATION EFFECTS ON THE S-I-N JUNCTION CURRENT. Takayama, Hajime (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 1, 1-14(Jul 1971).

A microscopic study of superconducting fluctuation effects is applied to the investigation of various tunneling currents through an $M_1/I/M_2$ junction in which the temperature is just above the transition temperature T_c of the metallic film M_2, and is well below that of the metal M_1. The main contribution to the current in the voltage region $eV \simeq T - T_c \ll T_c$ comes from the tunneling of Cooper pairs, existing temporarily in M_2 due to fluctuation. It is found out that this current exhibits a qualitatively different behavior according to the condition whether the transmission of particles through a barrier is specular or diffuse. If it is assumed to be specular, the behavior of the current agrees qualitatively with Ferrell's and Scalapino's results obtained by semi-phenomenological discussions for the fluctuations. (auth)

58937 NATURE OF ANOMALIES IN RESISTIVE STATE OF A SUPERCONDUCTOR. Smirnov, A. P.; Fedorov, N. F. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 3, 657-9(Sep 1971).

Translated from Fiz. Tverd. Tela; 13: No. 3, 796-8(Mar 1971).

Resistivity anomalies are examined for current-induced superconductivity loss in films of indium and tin. The potential difference varies nonmonotonically with current on account of bubble boiling of the helium, which also causes antihysteresis and resistance oscillations at constant current. The effects also involve heat transfer to the liquid in the boiling turbulent flow near the surface of the specimen. The anomalies vanish when gaseous helium is used. The role of heat effects is discussed for certain anomalies observed in other solid-state experiments with liquid helium and other liquids. (auth)

58938 IMPEDANCE MATCHING A JOSEPHSON GALVANOMETER BY MEANS OF A SUPERCONDUCTING TRANSFORMER. Clarke, John; Tennant, William E.; Woody, D. (Univ. of California, Berkeley). J. Appl. Phys.; 42: No. 10, 3859-65(Sep 1971).

The concept of an effective noise temperature is developed and applied to superconducting galvanometers. It is shown that even when the device is being used at a temperature above its noise temperature, Johnson noise in a source resistance may be observed only if this resistance is below a certain value, defined as the critical resistance. A detailed design is given for a superconducting transformer that matches the galvanometer to higher resistance and thereby appreciably increases the critical resistance. The transformer may be used at zero frequency. A practical transformer is described that has been used with the Josephson device known as the Slug. The transformer increased the critical resistance from 7×10^{-8} to 2×10^{-2} Ω and could be readily adapted to match to resistances up to 1 Ω. (auth)

58939 ROLE OF SPIN–ORBIT SCATTERING IN HIGH-FIELD SUPERCONDUCTING TUNNELING. Engler, Hans (Univ., Frankfurt am Main); Fulde, Peter. Z. Phys.; 247: No. 1, 1-8(1971).

The observation of the magnetic field splitting of the quasiparticle states in thin superconducting films does make it possible to determine the size of spin−orbit interactions via tunneling experiments. The tunneling density of states of such films in the presence of spin−orbit interactions is calculated and it is demonstrated that the tunneling conductance between two films of identical material in a parallel field should be an especially sensitive function of spin−orbit scattering. Numerical results for the tunneling density of states as well as for the tunneling conductance as function of spin−orbit scattering rate are presented. (auth)

58940 EFFECTS OF BISMUTH IMPURITY UPON THE CRITICAL FIELD CURVE OF SUPERCONDUCTING TIN. Green,

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Clarence Rufus. Clemson, S. C.; Clemson Univ. (1970). 88p. University Microfilms Order No. 71-17,405.

Thesis.

Approximately 40 cylindrically shaped quasi-single-crystal samples of tin doped with up to 1 at. % of bismuth impurity were prepared. The samples were 2 mm in diameter and were approximately 6 cm long. Measurements of the electrical resistivity of the samples were made at room temperature and at 4.2K to determine the residual resistivity ratio, which relates to a theoretical parameter in the theory of Markowitz and Kadanoff and in the theory of Clem. A technique for detecting the transition between the superconducting and normal phases was developed that reflected the change in magnetic susceptibility of the sample that occurs with the transition. The critical temperature was determined by linear extrapolation of the critical field to zero applied field; the critical field at absolute zero was obtained by extrapolation of H_c vs. t^2 to zero temperature. The slope of the critical field curve $(dH_c/dT_c)T_c$ was obtained from a least-squares fit of the critical field data near T_c to a straight line. The depression of T_c with addition of bismuth impurity is compared to and found to be in good agreement with the theory of Markowitz and Kadanoff and with the experimental data of Lynton, Serin and Zucker. The reduced slope of T_c for pure tin was found to lie between the values predicted by Clem and by BCS, differing from the value of Clem by about 3.5% and from the BCS value by about 1.1%. The theory of Clem predicts that the ratio H_0/T_c and the slope $(dH_c/dT)T_c$ should increase with doping to maximum deviations of 1.6% and 3% from the values for pure tin over the range of impurity concentrations used here. This work finds, however, that these quantities vary in the opposite sense from Clem's prediction, i.e., both H_0/T_c and $(dH_c/dT)T_c$ are observed to decrease initially with doping to maximum deviations of 7% and 5.5% from the corresponding values for pure tin. The reason for the discrepancy between theory and experiment is not understood. (TSS) (Diss. Abstr. Int., B)

58941 CRITICAL FIELD OF A SOLID CYLINDER WITH A COATING OF NORMAL METAL. Khamidullin, M. G. Fiz. Metal. Metalloved.; 31: No. 1, 30-6(Jan 1971). (In Russian).

Using the general macroscopic theory of superconductivity, the critical magnetic field of a solid superconducting cylinder covered with a thin film of normal metal is considered theoretically. An exact method of calculating the critical field as a function of the radius of the cylinder and the parameters of the associated magnetic system is presented. In the case in question the critical field is lower than that of a solid superconducting cylinder without a coating of normal metal; in other words, the superconductivity is partly suppressed by the coating. The critical field is an oscillatory function of the cylinder radius. (Metals Abstr.)

58942 ELECTRON MICROSCOPE INVESTIGATION OF THE STRUCTURE OF SUPERCONDUCTING ALLOY Ti–22 AT. PERCENT Nb. Vozilkin, V. A.; Buinov, N. N.; Bychkov, Yu. F.; (and others) (Inst. of Physics of Metals, Moscow. Lebedev Inst. of Physics, Moscow). Fiz. Metal. Metalloved.; 30: No. 4, 753-61(Oct 1970). (In Russian).

The structure of a superconducting Ti–22 at. % Nb alloy was studied by electron microscopy after various forms of heat treatment; the type of heat treatment leading to the appearance of ω- and α-phase precipitates was determined. Water-quenching from 800°C yielded ω-phase precipitates, the dimensions of which increased with increasing ageing temperature. Ageing above 450°C also yielded a high proportion of α-phase. The formation of ω- and α-phase precipitates 400 Å in dia was responsible for the high values of critical current density (2×10^{-3} A/cm^2) observed in some of the samples. (Metals Abstr.)

58943 DIRECT OBSERVATION OF SPIN-STATE MIXING IN SUPERCONDUCTORS. Tedrow, P. M.; Meservey, R. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 27: No. 14, 919-21(4 Oct 1971).

A peak in the tunneling conductance was observed between two very thin superconducting aluminum films in an intense parallel magnetic field at a voltage $V = (\Delta_1 + \Delta_2 - 2\mu H)/e$. The magnetic field dependence of this peak identifies it as that predicted by Engler and Fulde for spin-state mixing in superconductors. The spin–orbit scattering rate $b = \hbar/3\Delta\tau_{S.O.}$ obtained from this measurement is approximately 0.1. (auth)

58944 SUPERCONDUCTIVITY OF GALLIUM ARSENIDE AT HIGH PRESSURES. Berman, I. V.; Brandt, N. B.; Sidorov, V. I. (Moscow State Univ.). JETP Lett. (USSR) (Engl. Transl.); 14: No. 1, 11-12(5 Jul 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 1, 18-19(5 Jul 1971).

Superconductivity was observed in GaAs at pressures exceeding 250 kbar. In the pressure region 250 to 300 kbar, the resistance of the samples upon cooling from 240 to 5°K decreased by approximately 4 times. With further lowering of the temperature, sharply pronounced transitions to the superconducting state were observed. The temperature T_c of the transition into the superconducting state was 4.8°K at p = 260 kbar and decreased with further increase of pressure in the interval 260 to 300 kbar, at an average rate $dT_c/dp = 0.2 \times 10^{-5}$ deg/bar. (M.H.R.)

58945 DYNAMICAL FLUCTUATION OF THE ORDER PARAMETER AND DIAMAGNETISM OF SUPERCONDUCTORS. I. DIRTY LIMIT. Maki, Kazumi (Tohoku Univ., Sendai); Takayama, Hajime. J. Low Temp. Phys.; 5: No. 3, 313-23(Sep 1971).

Limiting attention to dirty superconductors, the fluctuation-induced diamagnetism above the superconducting transition is studied theoretically. It is found that the dynamical fluctuation is extremely important except in the immediate vicinity of the transition region [i.e., $T \cong T_c(H)$ or $H \cong H_{c2}(T)$, where H_{c2} is the upper critical field] and that this contribution does account for a large discrepancy between previous calculations and the recent experiment by Gollub, Beasley, and Tinkham. (auth)

58946 RESISTIVE BEHAVIOR OF THE SUPERCONDUCTING SURFACE SHEATH OF ALLOYS. Monceau, P.; Gilchrist, J. le G. (CNRS, Grenoble, France). J. Low Temp. Phys.; 5: No. 3, 363-75(Sep 1971).

Measurements are reported of the surface resistance of dirty Type-II superconductors driven into the surface-sheath regime by a static magnetic field, H_0, parallel or nearly parallel to the sample surfaces and transverse to the microwave current, in which condition the latter can excite fluctuations of the order parameter. A recent calculation by Maki has suggested that the surface resistance would be influenced by the presence of Kulik's vortex state even when the sample surface is polished and is as nearly as possible parallel to H_0. It is therefore proposed that the sample surface should be decomposed into elements that make different angles with HO, and the distribution of these angles described by a Gaussian, $\kappa_2(t)$, is deduced from the surface-resistance measurements near H_{c3}, so interpreted, and a temperature variation, $\kappa_2(t)/\kappa_2(l)$, is found that agrees reasonably with theory and with magnetization data, $[\kappa_2(l) \neq \lim_{t\to 1}(\kappa_2)]$. It is suggested that the anomalously large variation of $\kappa_2(t)$ reported by Fischer and Maki may have resulted from failure to take Kulik's vortices into account. In magnitude, present $\kappa_2(l)$ data agree with theory but not with magnetization data. (auth)

58947 PERIODIC MODES AND STRUCTURAL TRANSITION IN THE LABBE–FRIEDEL MODEL OF A_3B COMPOUNDS. Barisic, S. (Faculte des Sciences, Orsay, France). Solid State Commun.; 9: No. 17, 1507-12(1 Sep 1971).

The Labbe–Friedel model is applied to the computation of the phonon self-energy in A_3B compounds. It is shown that the linearized theory of the long-wavelength instability corresponds to the linearized Labbe–Friedel theory of the homogeneous deformation. The introduction of periodic modes does not change the first order of this transition, determined by higher-order energy terms. In the most interesting range or parameters the homogeneous deformation occurs at a temperature higher than the Kohn instability. The growth of the tetragonal phase stabilizes to some extent the Kohn mode in Nb_3Sn and the superconducting transition occurs for temperatures considerably higher than the critical temperature for the Kohn instability. (auth) (UK)

58948 SUPERCONDUCTING ALLOYS OF THE Nb–Al–Ge SYSTEM. Kalinin, G. P.; Vaulinskii, E. S.; Elyutin, O. P.; (and others). Metal Sci. Heat Treat. (USSR) (Engl. Transl.); No. 7-8, 676-8(Jul-Aug 1970).

Translated from Metalloved. Term. Obrab. Metal.; No. 8, 44-7(Aug 1970).

The properties of Nb–Al–Ge alloys in the pseudobinary Nb_3Al–Nb_3Ge section were investigated in order to obtain alloys with the highest superconducting transition temperature. On the diagram of composition vs. superconducting transition temperature for alloys of the Nb–Ge–Al system, there is a region of alloys with $T_c > 16$°K. This region is bounded by alloys with 75 to 76 at.% (89.6 to 91.6 wt.%) Nb, 3 to 5 at.% (2.8 to 4.5 wt.%) Ge, and the rest aluminum. To obtain high values of T_c it is necessary that the ratio of niobium to the total concentration of aluminum + germanium be strictly controlled (75 to 76 : 24 to 25). (TSS)

58949 EQUIVALENCE OF THE SUPERCONDUCTING TRANSITION TEMPERATURE OF PURE INDIUM AS DETERMINED BY ELECTRICAL RESISTANCE, MAGNETIC SUSCEPTIBILITY, AND HEAT-CAPACITY MEASUREMENTS. Soulen, Robert J. Jr.; Colwell, Jack H. (National Bureau of Standards, Washington, D. C.). J. Low Temp. Phys.; 5: No. 3, 325-33(Sep 1971).

The superconducting transition temperature of a well-annealed polycrystalline sample of pure indium was determined by three different techniques. The heat-capacity and susceptibility transitions are approximately 1 mK wide and span the same temperature interval. The resistance transition is less than 0.2 mK wide and occurs at the center of the other transitions. By choosing the midpoint of each transition the three measurements are identical to within 0.1 mK. (auth)

58950 ELECTRICAL BREAKDOWN OF COLD GASEOUS HELIUM. Meats, R. J. (Central Electricity Research Labs., Leatherhead, Eng.). pp 48-52 of Gas Discharges. London; Institution of Electrical Engineers (1970).

From International conference on gas discharges; London, England (15 Sep 1970). See CONF-700969.

Although a poor insulant for most practical purposes, He gas is a potential component of insulating systems for superconducting power devices, and at the very low temperatures relevant to superconductivity its density is about 15 kg/m^3 compared with 0.17 kg/m^3 at room temperature, leading to a considerable increase in its electrical breakdown field. An investigation of the uniform field direct-voltage breakdown characteristics of He was carried out from 4.2 to 10 K, covering the temperature range for superconductive power applications. Results indicated that He is very suitable as a dielectric for superconducting power cables and similar devices. (UK)

Equipment and Devices

Refer also to abstract 59160.

58951 SUPERCONDUCTIVE COMPOSITES. Maddock, B. J. Composites; 1: No. 2, 104-11(Dec 1969).

Ordinary conductors are generally used in composites with superconductors to control resistance and temperature increases. Conductors based on Nb–Ti superconductors are formed by cladding with Cu and then processing by standard techniques such as forging, swaging, extrusion or rolling. Conductors of Nb–Ti, which must be adiabatically stable, can be produced by twisting the filaments in a Cu matrix or by using a matrix of a Cu–Ni alloy. The more brittle Nb_3Sn superconductors are produced as thin layers on a Cu or stainless steel substrate by either vapor deposition or a diffusion process. Current and potential applications for the composites include electromagnets, electrical-power transmission cables, pulse-energy storage devices, and prototype MHD generators. (Metals Abstr.)

58952 NONISOTHERMAL SUPERCONDUCTING BOLOMETER. II. Konovodchenko, V. A.; Dmitriev, V. M.; Komarevskii, S. K.; Loktionov, N. F. Sb. Nauch. Tr., Fiz.-Tekh. Inst. Nizk. Temp., Akad. Nauk Ukr. SSR; No. 9, 72-84(1970). (In Russian).

The most general stationary problem of thermal conductivity of nonisothermal superconducting bolometers is studied, and a method of graphoanalytical investigation of its characteristics is developed. A system of equations for determining the current coordinates of the boundaries of the sections of the superconducting bolometer with different states of the superconductor was obtained as a result of solving this problem. A number of special cases of solving the system are investigated, which along with having independent value, also turn out to be very useful when writing and developing the program for its complete solution. (TSS) (JPRS)

58953 ELECTRICAL CONDUCTORS INCLUDING SUPERCONDUCTOR MATERIAL. (to Siemens Aktiengesellschaft). British Patent 1,247,832. 29 Sep 1971. Priority date 25 Jun 1969, Germany.

An electrical conductor is described that is comprised by a tube, for carrying coolant, and a strip-form conductive assembly extending alongside the tube and fixed flat against a lateral external face. The strip-form conductive assembly is comprised by wires of superconductor material embedded in normally electrically conducting metal at an operating temperature at which the superconductor material is in its superconducting state. These wires extend along the strip-form assembly but are twisted about a longitudinal axis of the assembly. The tube is made of metal that is normally electrically conductive at the operating temperature. (M.H.R.)

58954 SUPERCONDUCTING CONDUCTOR. Royet, Jean (to Compagnie Generale d'Electricite). British Patent 1,247,260. 22 Sep 1971. Filed 24 Dec 1969.

The conductor described is comprised of a wire or strip of superconducting material located within a tube made of a material having, at normal temperatures, an electrical conductivity of the order of that of Al. The superconductivity material may be parallel to, or extend helically around, the axis of the tube. A sheathing envelops the tube, in good thermal and electrical contact therewith; this sheathing consists preferably of Al alloy, applied around the tube by an extrusion method. (UK)

Plasma and Thermonuclear Physics

Refer also to abstract 58739.

58955 TECHNOLOGY INDEX FOR PLASMAPHYSICS RESEARCH AND FUSION REACTORS. VOLUME 5, NO. 7, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 45p.

This listing includes 217 references on various aspects of controlled thermonuclear research. (M.O.W.)

58956 GLOBAL TEMPERATURE EFFECTS OF THE USE OF FUSION ENERGY AND THE FUSION TORCH. Porter, W. A.; Hagler, M. O.; Kristiansen, M. (Texas Tech. Univ., Lubbock). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 31-6(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Per capita energy requirements for the world are projected for 2000 AD and 2020 AD. The release of this energy will cause the surface temperature of the earth to rise. This places a limit on world population in terms of standard of living and increase in surface temperature. (auth)

58957 FIZIKA PLAZMY I PROBLEMY UPRAVLYAEMOGO TERMOYADERNOGO SINTEZA. VYPUSK I. (Plasma Physics and Problems of Controlled Thermonuclear Synthesis. Number 1). Eight Annual Conference Held at Kharkov, May 20–28, 1968. Tolok, V. T. (ed.). Kiev; Naukova Dumka (1971). 304p. (CONF-680565).

This collection of 35 papers was presented at the Eighth Annual Conference on Plasma Physics and Problems of Controlled Thermonuclear Synthesis held May 20 to 28, 1968, at Khar'kov in Russia. The results of experimental and theoretical investigations of the high-frequency properties of a gaseous discharge plasma are discussed. Nearly half of the papers are concerned with the interaction of beams of charged particles with a plasma. Fewer papers are devoted to gaseous discharge and problems of instability. (K.S.W.)

Confinement and Heating

Refer also to abstracts 59033 and 59054.

58958 (CEA-CONF-1807) PLASMA CONFINEMENT IN THE DECA II B CIRCULARIZED MAGNETIC WELL. Launodis, D.; Lecoustey, P.; Nicolas, M.; Tachon, J.; Kesner, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1971. 3p. (In French). (CONF-710527-8). Dep. NTIS (U. S. Sales Only).

From Physics conference; Evian, France (25 May 1971).

The plasma equilibrium is stable against flutes in spite of the shallow well of DECA II B. The ionic distribution function is minimum for a given angle at the beginning of the confinement. It changes during 600 μsec to reach a maximum for the same value of this angle. The causes of this change are discussed. (France)

58959 (CEA-CONF-1830) PARAMETER STUDY FOR A TRANSIT TIME MAGNETIC PUMPING EXPERIMENT IN A TORUS. Brambilla, M.; Giuffre, S. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1971]. 4p. (CONF-710920-1). Dep. NTIS (U. S. Sales Only).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

Transit-time magnetic pumping is a slow process and must be performed in a machine already having good performances. It is shown that a T.T.M.P. experiment is possible in a Stellarator or a Tokamak having the same size as the existing devices. (France)

58960 (CEA-CONF-1831) PLASMA HEATING AT THE LOWER-HYBRID RESONANCE. Capitain, J. J.; Ichtchenko, G.; Lallia, P.; Moulin, D.; Nguyen, T. K.; Pesic, S. S. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1971]. 4p. (CONF-710920-4). Dep. NTIS (U. S. Sales Only).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

In order to investigate the efficiency of noncollisional absorption mechanisms at high frequencies, an experimental study of the lower hybrid heating of a dense laser-produced plasma was made. The lower hybrid resonance occurred when the electron density was $2 \times 10^{14}/cm^3$. The absorption of a small part of the incident

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power must be sufficient to make the collisionless contribution to the heating lower than the collisional one. (France)

58961 (CONF-711016–1) CONTAINMENT IN TOKAMAK AND BUMPY TORUS. Dory, R. A.; Guest, G. E.; Harris, E. G.; Hogan, J. T.; Widner, M. M. (Oak Ridge National Lab., Tenn.). [nd]. 4p. Dep. NTIS.

From Conference on plasma theory; Kiev, USSR (19 Oct 1971).

The energy flow and current diffusion in tokamaks were studied theoretically. It is concluded that tokamak confinement can lead to thermonuclear regimes if optimistic scaling laws hold true. A brief discussion on the bumpy torus concept is also given. (M.O.W.)

58962 (IPP-IV–25) SIMPLE LOW-LOSS COUPLING METHOD FOR RF HEATING OF PLASMA IONS BY ELECTROSTATIC ION-CYCLOTRON WAVES. Puri, S.; Tutter, M. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Aug 1971. 11p. Dep. NTIS (U. S. Sales Only).

It is proposed to excite TEM waves in a cylindrical coaxial waveguide consisting of a metallic outer conductor with the plasma acting as the inner conductor. It is found that for frequencies of the order of the ion gyrofrequency, the penetration depth of the TEM wave fields into the plasma generally exceeds the wavelength of the electrostatic ion-cyclotron waves. The electrostatic ion-cyclotron waves thus excited propagate radially into the plasma and are collisionally absorbed if the time of energy propagation (at the wave's group velocity) over a distance of plasma diameter is of the order of or greater than the energy equipartition time due to ion–ion collisions. Numerical calculations for some representative examples indicate that this method could be used to heat plasma ions with a rather high efficiency. (auth)

58963 EXPERIMENT ON THE OHMIC HEATING OF PLASMA IN THE HELIOTRON C MAGNETIC FIELD. I. EQUILIBRIUM. Oshiyama, Hiroshi; Mohri, Akihiro; Ariga, Seiich; (and others) (Kyoto Univ.). J. Phys. Soc. Jap.: 31: No. 4, 1213-20(Oct 1971).

The equilibrium of the current-carrying toroidal plasma in the Heliotron C field is studied experimentally. The equilibrium state is very sensitive to a change in the transverse field of order 10^{-3} of the main confining field. The effect of a vertical magnetic field on the equilibrium is precisely examined by measuring the electrostatic equipotential surface of the plasma and the apparent electric conductivity of the plasma current. The observed values of the optimum vertical field B_v, which is necessary for the equilibrium of a current-carrying toroidal plasma, are about $\frac{1}{2}$ to $\frac{1}{3}$ of the theoretical values. (auth)

58964 ADIABATIC COMPRESSION OF PLASMA IN TRAPPED-PARTICLE-FREE STELLARATOR. Ikuta, Kazunari (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 31: No. 4, 1237-9(Oct 1971).

The combination of the toroidal hf electric field and the stellarators with stellarator winding located on the major radius side is shown to be a possible stationary fusion reactor. The fusion ignition condition is attainable by the major radius compression of toroidal plasma. (auth)

58965 AVERAGED EQUATIONS OF LASER HEATING OF D–T PLASMA TAKING INTO CONSIDERATION THE HEAT OF THERMONUCLEAR FUSION. Kaliski, S. (Inst. of Fundamental Tech. Problems, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 19: No. 5, 397-403(1971).

Averaged equations for laser heating and expansion of D–T plasma are derived, taking into consideration the heat of thermonuclear fusion generated during this process. Despite the simplifications achieved by averaging (replacement of partial equations by ordinary ones), rejection of the propagation effects, shock waves, etc., the equation of the problem is still very complex. It is an ordinary differential equation of strong nonlinearity, with retarded argument, depending in a nonlinear manner on the solution and its derivatives. The equation of the problem can be considerably simplified, depending on the quantitative features of the problem; some particular cases are dealt with separately. (auth)

58966 HIGH-FREQUENCY HEATING IN TOKAMAKS. Klima, R. (International Centre for Theoretical Physics, Trieste, Italy). Nucl. Fusion; 11: No. 4, 357-62(Aug 1971).

The propagation of a magnetosonic wave in a tokamak device is considered, assuming plasma with two kinds of ions. The wave excited on the inner boundary of the tokamak torus penetrates into the high-density region under conditions that seem to be experimentally plausible. The energy of the wave can be absorbed in the high-density region via the Buchsbaum hybrid resonance and/or the transit time damping on electrons. (auth)

58967 PLASMA LOSSES IN HIGH-CURRENT PLASMA CONFIGURATIONS DUE TO THE INVERSE SKIN EFFECT. Kvartskhava, I. F.; Matveev, Yu. V.; Khautiev, E. Yu. (Physical-Technical Inst., Sukhumi, USSR). Nucl. Fusion; 11: No. 4, 349-55(Aug 1971).

Experiments on zeta pinches have shown that the surface layer of the plasma can be ejected towards the walls of the chamber. Phenomena of this type usually develop when the discharge current flowing through the circuit is decreasing, but they can also occur with a rising current when there is recurring discharge ignition. The application of an axial magnetic field does not prevent the surface layer of the plasma from being ejected towards the chamber walls; it merely limits the rate at which the process occurs. It is shown that the breakup of the plasma sheath is due mainly to a reverse current induced in the surface layer of the pinch. When the discharge current is decreasing, a reverse current is produced by the "inverse skin effect." It is suggested that plasma losses due to the "inverse skin effect" may also be observed for certain discharge régimes in theta-pinch, zeta, Tokamak, and other systems. (auth)

58968 STOCHASTIC MODEL OF ELECTRON-CYCLOTRON HEATING IN A MAGNETIC MIRROR. Kawamura, T.; Momota, H.; Namba, C.; Terashima, Y. (Nagoya Univ., Japan). Nucl. Fusion; 11: No. 4, 339-47(Aug 1971).

A heating mechanism of electron plasmas by high-power microwaves in a magnetic mirror is investigated theoretically, with reference to experiments in a device named TP–M. The heating is assumed to be due to a microwave mode propagating perpendicular to the magnetic field since higher harmonic resonances, the main features of the experiments, exist. The heating mechanism can be interpreted in terms of a stochastic process, a random walk in velocity space. It is confirmed numerically that localized resonance zones of finite width exist, the electrons are effectively heated only in the resonance zones, and that the presence of a randomization process of the relative phase relation between the wave and the electron gyration is essential for the heating process. On the basis of the numerical analysis, the heating process is treated analytically. The electrons are assumed to pass the resonance zones repeatedly in the course of oscillatory motions between turning points, and the relative phase relation is assumed to be random at each passage through the resonance zone. The heating rate is calculated and found to agree with the experimental value. The causes of phase randomization, the effects of the loss cone, and the observed saturation of electron temperature are also discussed. (auth)

58969 TARGET PLASMA TRAPPING. Colchin, R. J. (Oak Ridge National Lab., Tenn.). Nucl. Fusion; 11: No. 4, 329-37(Aug 1971).

The trapping of neutrals from a fast atom beam impinging on an electron–cyclotron-plasma target is studied. The electron–cyclotron plasma is assumed to be fed by an influx of molecular hydrogen. Radial attenuation of the feed gas and the H^0 formed by its dissociation is considered in detail. Both the addition of neutrals and depletion of the target by charge exchange with the beam are also taken into account, as is reflux from nearby walls. Given a sufficiently high target density ($\gtrsim 10^{13}$ protons/cm^3), a sufficiently low background density, and a 0.01 to 1.0-A neutral beam, it is calculated that 10^{11} to 10^{13} protons/cm^3 can be accumulated with a trapping efficiency of several per cent. (auth)

58970 ASPECT OF PLASMA DIFFUSION IN MULTIPOLES. Tanaka, M.; Takeda, T. (Japan Atomic Energy Research Inst., Tokai). Nucl. Fusion; 11: No. 4, 389-90(Aug 1971).

The diffusion of plasma in multipoles is considered for various directions, i.e., towards the current-carrying inner conductors and the outer wall. A brief theoretical discussion is given. (M.O.W.)

58971 PLASMA HEATING AT THE SECOND HARMONIC OF THE ELECTRON CYCLOTRON FREQUENCY. Patrushev, B. I.; Gozak, V. P.; Frank-Kamenetskii, D. A. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 542-3(Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 692-3(Apr 1971).

The interaction of microwaves with plasma in a magnetic field having values close to those required for cyclotron resonance was studied experimentally in an open magnetic mirror configuration. It is found that at the second harmonic the plasma heating exhibits a resonance. Hot electrons are observed together with an instability in the form of a noise band at the third harmonic. (auth)

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58972 EFFECT OF MAGNETIC FIELD ON THE HEATING OF A HOT PLASMA CREATED BY AN ELECTRON BEAM. Bredikhin, M. Yu.; Maslov, A. I.; Skibenko, A. I.; Skibenko, E. I.; Yuferov, V. B. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 544-5(Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 694-5(Apr 1971).

The possibility of heating a dense plasma by an electron beam injected in a magnetic mirror configuration was investigated experimentally. The heating efficiency is enhanced when the magnetic field at the center of the mirror is increased. For a constant density $N = 7 \times 10^{13}$ cm^{-3} the plasma energy density is 10^{17} eV/cm^3. (auth)

58973 COLLISIONLESS PLASMA HEATING AT THE ION CYCLOTRON RESONANCE. Cattanei, G. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Phys. Rev. Lett.; 27: No. 15, 980-2(11 Oct 1971).

A variant of the method proposed by Stix for heating a plasma at the ion cyclotron resonance is presented. It is efficient for a wide range of densities and suitable for small aspect-ratio (r/R) toroidal configurations. An estimate of the resistive plasma loading is given and compared with the inductive reactance or, alternatively, with the Ohmic losses of the coil. (auth)

58974 DEPENDENCE OF THE ENERGY LOSS FROM A TOKAMAK PLASMA ON THE EFFECTIVE ELECTRON COLLISION FREQUENCY. Bobrovskii, G. A.; Razumova, K. A. JETP Lett. (USSR) (Engl. Transl.); 14: No. 3, 99-100(5 Aug 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 3, 153-4(5 Aug 1971).

In a discharge of relatively large hydrogen pressure, the electron temperature at a given current is practically independent of the density in a wide interval. Such a weak $T_e n_e$ dependence makes it possible to trace the variation of the transport coefficients with varying density or effective collision frequency ν_{eff}. Diagrams are given of plasma pressure versus ν_{eff}. (M.O.W.)

58975 INFLUENCE OF LONGITUDINAL STREAMS OF CHARGED PARTICLES ON THE DIFFUSION OF PLASMA IN A STELLARATOR. Kossyi, I. A. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 3, 124-7(5 Aug 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 3, 188-91(5 Aug 1971).

In order to explain the mechanism of plasma loss in closed traps, the existence of an average velocity of the ion component (u_{z_i}) along the minor axis of the toroidal chamber of the L-1 stellarator is analyzed. An earlier analysis enabled one to state that the longitudinal ion streams should of necessity arise in closed traps in the regime of weak collisional plasma with a radial electric field E_γ. Electron diffusion in the traps is described. (M.O.W.)

58976 INFLUENCE OF HIGH-FREQUENCY POTENTIAL OF A TOROIDAL ELECTRIC FIELD ON THE TRAPPING OF CHARGED PARTICLES IN A CLOSED MAGNETIC TRAP. Demirkhanov, R. A.; Stotland, M. A.; Khil, Sh. V.; Baratov, D. G. JETP Lett. (USSR) (Engl. Transl.); 14: No. 3, 122-4(5 Aug 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 3, 184-7(5 Aug 1971).

Attention is called to the fact that the toroidal inhomogeneity of the longitudinal electric field, possessed by closed traps, can lead, in the case of an hf electric field, to an increase of the degree of trapping of the particles and to a deterioration of their containment. Diagrams are given of trajectories of the particles with initial values $V_\perp/V_0 = 0.9$ on the meridional plane. The effects of hf fields are shown. (M.O.W.)

Diagnostics

58977 (AEC-tr-7271) PLASMA DENSITY MEASUREMENT BY MEANS OF AN OPEN RESONATOR. Ulshmid, I.; Bez'yazychnii, I. A. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report KHFTI-69-51. 19p. Dep. NTIS.

A survey is given of plasma density measurements in a metal chamber using an open-resonator method. The performance of the open-resonator method is discussed. (M.O.W.)

58978 (CEA-CONF-1829) OPTICAL METHOD FOR STUDYING THE ION VELOCITY IN AN ACCELERATED PLASMA BEAM. Hess, W. R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1971]. 4p. (CONF-710920-7). Dep. NTIS (U. S. Sales Only).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

Charge exchange with excitation from energetic ions in a residual neutral gas in plasma experimental devices can be used for plasma diagnostics. An optical method for measuring the proton velocity distribution in a hot plasma source is described. (France)

58979 (JAERI-Memo-4530) MICROWAVE INTERFEROMETRIC MEASUREMENTS IN THE MEDIUM-BETA TORUS (JFT-2). Funahashi, Akimasa; Itoh, Satoshi (Japan Atomic Energy Research Inst., Tokyo). Jul 1971. 24p. (In Japanese). Dep. NTIS (U. S. Sales Only).

Eight-channel, 2-mm microwave interferometric measurements were made in order to determine the distribution of plasma density in the Tokamak-type apparatus, JFT-2. The plasma density measurements performed in Tokamak apparatus are first reviewed. Then, the 2-mm wave measurements in the JFT-2 apparatus are explained in detail, including the multichannel interferometric circuits and the numerical method of determining the density distributions without axial symmetry from the measured phase shifts. In addition, the refractive shift of the 2-mm wave path due to the radial distribution of plasma density is also discussed. The report is expected to be a manual for obtaining the density distributions from the observed interferometric traces. (auth) (Japan)

58980 (JAERI-Memo-4531) MEASUREMENT OF THE PLASMA CURRENT DISTRIBUTION IN A TOKAMAK DEVICE WITH ALPHA-PARTICLES INJECTED TRANSVERSE OR PARALLEL TO THE TOROIDAL AXIS. Kawasaki, S.; Inoue, K.; Takeda, T.; Yoshikawa, M. (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Jul 1971. 31p. Dep. NTIS (U. S. Sales Only).

A method is proposed for measuring the current distribution in a tokamak plasma column by injecting α particles from a radioisotope. In this method, the plasma current distribution is determined by injecting the α particles into a plasma column and analyzing their orbits with and without the plasma current. The orbit analysis is presented for the axisymmetric linear geometry. The deviation calculated for the JFT-2 tokamak parameters indicates that the present method is feasible. The problems of measurement resolution, toroidal effect, α source, and detector are also described. (auth) (Japan)

58981 EFFECT OF ELECTRON AND ION DRIFTS ON DOUBLE PROBES. Ariga, Seiichi (Kyoto Univ.). J. Phys. Soc. Jap.; 31: No. 4, 1221-31(Oct 1971).

The characteristics of double probes immersed in plasmas in which electrons and ions have drifted Maxwellian distributions are theoretically investigated by computer. The results about a double probe with "two frontal electrodes" show that the electron drift changes the inclination of the characteristic curve; therefore, the electron temperature estimated from the curve contains an appreciable error. On the contrary, the results about a probe with "back-to-back electrodes" show that the electron drift shifts the idealized characteristic curve parallel to the potential axis of the figure and the ion drift parallel to the current axis, but the original pattern is still conserved; therefore, the estimated temperature is valid in this case when the drift velocity of electrons or ions is far lower than their thermal velocity. (auth)

58982 THEORY OF A COOLED SPHERICAL ELECTROSTATIC PROBE IN A CONTINUUM GAS. Chapkis, Robert L.; Baum, Eric (TRW Systems Group, Redondo Beach, Calif.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 10, 1963-8 (Oct 1971).

The idealized problem of a cooled spherical electrostatic probe in a quiescent continuum slightly ionized chemically frozen gas was investigated. The electron temperature is described by two limiting models; either the electrons are assumed to be at local thermal equilibrium, or they are assumed frozen at the ambient temperature far from the probe. From numerical solutions of the governing equations, it was found that with the frozen electron temperature assumption, the probe characteristics for a cold probe are only slightly altered from those of an adiabatic probe. With the electrons at thermal equilibrium, the probe characteristic is only slightly altered when the bias potential is large, but significant changes in the probe characteristics do occur when the bias potential is small, including a significant shift in the floating potential. (auth)

58983 PROBE GEOMETRY EFFECTS ON TURBULENT PLASMA DIAGNOSTICS. Ghosh, A. K.; Richard, C. (RCA Victor Co., Ltd., Montreal). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 10, 2104-6(Oct 1971).

XUM

Studies were made on the perturbing effects of probe geometry on the turbulent plasma parameters when they are used to measure the local statistical properties of turbulent plasma flows. The effects studied are: 1) frequency filtering effects of the cylindrical electrostatic probes on the power-frequency spectrum when placed axially along the turbulent plasma flow. 2) The "wake" effect of an upstream probe on a downstream probe when the pair is used to measure various statistical moments of the turbulent plasma flow. (M.O.W.)

58984 INTERFEROMETRIC DETERMINATION OF TEMPERATURE IN A LAMINAR JET OF ARGON OR NEON PLASMA. Czernichowski, A. (Wroclaw Technical Univ.). Acta Phys. Pol.; A40: No. 3, 283-94(Sep 1971).

A Mach–Zehnder interferometer and an He–Ne laser were used in determinations of the temperature in a laminar jet of argon or neon plasma achieved in a plasmatron. Presented here are the measuring technique, the equipment used, and the numerical method of analyzing the interferograms of the jets of axial symmetry. (auth)

58985 PLASMA TEMPERATURE DETERMINATIONS NEAR A DIELECTRIC SURFACE. Andreev, S. I.; Gavrilov, V. E. Zh. Prikl. Spektrosk.; 14: No. 3, 524-7(Mar 1971). (In Russian).

Plasma temperature was determined at a quartz wall boundary. In the case when a radiative energy stream predominates, the temperature of the plasma remains high in the boundary layer 10^{-2} cm thick and comprises approximately 80% of the temperature of the plasma measured 1 to 2 mm distant from the wall. (tr-auth)

58986 MEASUREMENT OF THE PARAMETERS OF A CESIUM PLASMA. COMPARISON OF THE RESULTS OBTAINED USING A HOT LANGMUIR PROBE WITH THOSE OBTAINED USING A COOLED PROBE. Michel, Claude; Kornmann, Michel; Cussenot, J. R. (Nancy Univ.). Compt. Rend., Ser. B; 272: No. 24, 1350-3(14 Jun 1971). (In French).

When the parameters of a hot-cathode cesium plasma are determined with a Langmuir probe, secondary emission currents from the collector surface and a poorly defined work function can introduce considerable error. These inconveniences can be suppressed by cooling the collector surface. (France)

58987 EXPERIMENTAL DETERMINATION OF THE ELECTRON CONCENTRATION AND TEMPERATURE OF AN ARGON PLASMA JET BY MEANS OF LASERS. Aksenov, V. V.; Bespalov, M. S.; Eroshenko, V. M.; Mushinskii, A. A. Zh. Prikl. Spektrosk.; 14: No. 3, 393-6(Mar 1971). (In Russian).

The electron temperature and density were experimentally determined by means of a laser of modulated figure of merit. An argon plasma jet was obtained at atmospheric pressure in a water-cooled 3.5 KV plasmatron. The electron temperature and concentration were derived from the spectrum of scattered radiation, and are equivalent to the corresponding values obtained from the spectroscopic method. (tr-auth)

58988 TEMPERATURE MEASUREMENT OF HEAVY PARTICLES IN A PLASMA IN A MAGNETIC FIELD. Khmelinin, B. A. Zh. Prikl. Spektrosk.; 14: No. 1, 37-40(Jan 1971). (In Russian).

The method of measuring the temperature of atoms and ions according to the Doppler broadening of lines during the combined effects of Doppler and Zeeman was investigated for the case when it is possible to neglect relatively small concentrations of electrons by the Stark effect. The dependence of the Doppler line broadening on the experimental half-width was calculated for a series of lines of neutral and ionized argon. The limiting concentration of electrons was calculated as a function of the measured temperatures for a series of argon lines. (tr-auth)

58989 DEVICE FOR MEASUREMENT OF TIME-RESOLVED PROFILES OF A LINE SPECTRUM EMITTED FROM A PLASMA. Goto, Seiichi; Ishimura, Tsutomu (Osaka Univ.). Jap. J. Appl. Phys.; 10: No. 10, 1450-8(Oct 1971).

A device is constructed to display eight successive time-resolved profiles of a spectral line from a pulsed plasma on the screen of a usual oscilloscope. It takes 2 μs to display one profile and the time interval between two successive profiles is chosen to be 10, 15, 20, or 30 μs. The wavelength band width of each picture on the screen is chosen to be 15, 10, or 6.3 Å. The device is composed of a grating monochromator, a set of 3 light guides of 16 channels, and an electronic signal processor. The signals corresponding to the 16 wavelength components are sampled and mixed in the processor so that the resultant signal is fed to the vertical input terminal of the oscilloscope. Simultaneously, the horizontal sweep and the brightness modulation waveforms are produced by the processor and applied to the corresponding terminals. (auth)

58990 DOUBLE MICROFIELD PROBE. Storey, Owen; Chauliaguet, Charles (Centre National de la Recherche Scientifique, Saint-Maur-des-Fosses, France). Compt. Rend., Ser. B; 272: No. 26, 1496-9(28 Jun 1971). (In French).

It is suggested that the electron density and electron temperature of a plasma may be determined from measurements made as a function of frequency of the crossed spectra of two random signals received by two small dipole antennas in the medium. These spectra were studied for a plasma in thermal equilibrium, without a magnetic field, and free from collisions. It presents a maximum just above the plasma frequency; this maximum becomes sharper on increasing the separation of the antennas in relation to the Debye length. (France)

58991 SPECTRAL DIAGNOSTICS OF ARGON AND NEON PLASMAS IN PSEUDO EQUILIBRIUM. Czernichowski, A. (Ecole Polytechnique, Wroclaw). Acta Phys. Pol.; A40: No. 3, 295-308(Sep 1971). (In French).

Using spectral methods, electron density distributions and the excited-state density of Ar I and Ne I in a laminar jet of argon and neon plasma produced in a plasmatron were studied. The parameters for the temperature distribution of neutrals were compared. This distribution was determined with the help of a Pitot tube and the Mach–Zehnder interferometer. It was found that the populations relative to all the excited levels as well as the electron density correspond to equilibrium for the temperature of the neutrals (about 4000°K), but that the absolute values of the populations are very high and correspond to a temperature of 10,000°K. (tr-auth)

58992 PLASMA POTENTIAL MEASUREMENT. Makov, B. N. Dokl. Akad. Nauk SSSR; 198: No. 2, 327-9(11 May 1971). (In Russian).

An electrode immersed in a plasma, and with a different potential, is surrounded by a narrow region of space charge, the thickness of which is determined by the Child–Langmuir law. A novel method of determining the plasma potential is offered if the space charge is absent on the surface of the probe, a condition which evidences a disappearance of electrical field between the probe and the plasma. A schematic diagram of the probe circuitry is provided, and its mode of operation is outlined. (K.S.W.)

58993 DETERMINATION OF PLASMA PARAMETERS ACCORDING TO INTENSITY OF CONTINUOUS SPECTRA. Chelnokov, M. B. (Moscow Aviation Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 12-17(1969). (In Russian).

The relation between the spectral intensity of recombination radiation and the recombination coefficient is obtained. It is shown that determination of electron temperature according to the intensity of the continuous spectra is possible even in the unknown relation of intensities of recombination and bremsstrahlung. Methods are developed for determination of recombination coefficients and electron velocity distribution functions according to the intensity of the continuous spectra. (tr-auth)

58994 CORPUSCULAR PLASMA DIAGNOSTICS. Afrosimov, V. V. (Ioffe Inst. of Physics and Tech., Leningrad). pp 535-62 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Plasma energy loss determination by measurement of associated particle fluxes is described. Plasma diagnostics using interacting charged-particle beams are then discussed. 26 references. (M.O.W.)

58995 METHODS OF PLASMA INVESTIGATION BY MICROWAVE REFLECTION. Ipatov, V. A. (Ioffe Inst. of Physics and Tech., Leningrad). pp 614-33 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

The application of the reflected-wave method in plasma diagnostics is discussed and it is shown that the region of applicability can be extended to the range of density from n = 0 to n = $10^4 n_{cr}$. (M.O.W.)

58996 METHODS OF INVESTIGATION OF TURBULENT PHENOMENA IN PLASMA BY SCATTERING OF SHF WAVES. Larionov, M. M. (Ioffe Inst. of Physics and Tech., Leningrad). pp 634-52 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Theoretical analyses are presented for different cases of super-high-frequency wave scattering on various fluctuations in turbulent plasmas. Various incident angles for the shf waves are considered in particular. (M.O.W.)

58997 EXPERIMENTAL INVESTIGATION AND APPLICATION TO PLASMA DIAGNOSTICS OF THE DOPPLER EFFECT AT THE CYCLOTRON FREQUENCY. Ivanov, B. I. (Physical-Technical Inst., Kharkov). pp 653-77 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

The possibility of application of the Doppler effect at the electron cyclotron frequency for the investigation of electron longitudinal velocity distributions in plasmas and beams is considered. Relations establishing the correspondence between the line profile of cyclotron damping and the electron distribution function are given. The Doppler effect at the electron cyclotron frequency is studied experimentally. The measurements are carried out on an electron beam passing along the axis of an overmoded cavity in the 10-cm band. Both nonrelativistic and relativistic Doppler shifts of the electron cyclotron frequency were observed. On the basis of these investigations, a new shf method for the electron distribution functions is proposed. The method is used to determine the electron velocity distribution in a beam–plasma discharge. A comparison of the new method with the retarding-potential method was made and satisfactory results were obtained. An advantage of the newly developed method is the possiblity to measure the absolute (not relative) values of the velocity distribution function without introducing perturbing bodies in contact with the plasma. (auth)

58998 INVESTIGATIONS IN PHYSICAL CHEMISTRY OF THE ARC PLASMA. Vukanovic, V. (Univ., Belgrade). pp 706-28 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Spectral analysis of a gaseous plasma in free-burning arcs is discussed from the physical chemistry standpoint. A brief theoretical analysis of the problem is presented. (M.O.W.)

58999 BEHAVIOUR OF LOW-DENSITY PLASMA IN THE PRESENCE OF CYLINDRICAL LANGMUIR PROBES. Szuszczewicz, E. P.; Weber, A. H. (St. Louis Univ.). pp 147-51 of Gas Discharges. London; Institution of Electrical Engineers (1970).

From International conference on gas discharges; London, England (15 Sep 1970). See CONF-700969.

It is stated that although the use of electrostatic probes in plasma diagnostics has had a relatively long history, the problem of interpreting Langmuir probe current–voltage characteristics is not completely solved for the entire range of probe–plasma parameters. The theoretical and experimental work done in this field is reviewed, and in particular that of Laframboise (UTIAS Report No. 100(1966)). Both collisionless plasmas and collision effects are discussed, and particular reference is made to OML (orbital motion limited) current behavior. (UK)

59000 PLASMA DIAGNOSTICS OF A URANIUM PLASMA. Schneider, R. T.; Kylstra, C. D.; Campbell, H. D. (Univ. of Florida, Gainesville). pp 157-61 of Gas Discharges. London; Institution of Electrical Engineers (1970).

From International conference on gas discharges; London, England (15 Sep 1970). See CONF-700969.

The development of plasma core nuclear reactors for propulsion or other applications such as nuclear pumped lasers will require a knowledge of the radiation emitted by uranium plasmas as a function of operating pressures, temperatures, wavelengths, and geometry. A knowledge is also needed of plasma composition (partial pressure distribution of the various U ionic species and the electrons). Calculations concerning criticality, radiative heat transfer to the working fluid, and system startup and control all require this information. These calculations must at present rest on theoretical predictions of radiation emission and plasma composition, but little is known concerning U plasma physical constants, particularly at the temperatures and pressures usually quoted for propulsion plasma core reactors. Some initial measurements on a U plasma are described, together with the diagnostic methods developed to analyze the data. The measurements included emission and absorption coefficients as a function of pressure and temperature, and results are reported for a plasma of pressure 0.1 to 0.5 atm. at 7,500 to 10,000K. Novel methods for diagnosing U plasmas were developed. (UK)

59001 PLASMA DIAGNOSTICS UTILISING OPTICAL INTERFEROMETRY AND HOLOGRAPHIC TECHNIQUES. Friedrich, O. M. (Univ. of Texas, Austin); Weigl, F.; Dougal, A. A. pp 557-61 of Gas Discharges. London; Institution of Electrical Engineers (1970).

From International conference on gas discharges; London, England (15 Sep 1970). See CONF-700969.

It is stated that two-beam optical interferometry and holographic techniques are very valuable for space- and time-resolved quantitative measurements of the refractive index of transparent media, and the possibility of using optical holography for plasma diagnostics was demonstrated by Ostrovskaya and Ostrovskii in 1966; employing holographic techniques they determined the refractive index of the plasma produced by a laser-induced spark. The principles of holography are outlined and it is stated that a hologram permits storing light waves that have passed through a plasma and later studying changes introduced in the light waves by the plasma. Advantages of optical holographic techniques for plasma diagnostics include the possibility of determining the spatial distribution of plasma parameters, optical recording which can be made insensitive to the self-radiation of the plasma, optical interferometry without high-quality optical windows on the plasma vessel by employing double-pulse differential holographic interferometry, and variable-sensitivitv interferometry. These aspects are discussed in detail. (UK)

Kinetics (General)

59002 LOW-PRESSURE TOROIDAL GLOW DISCHARGE IN THE RADIAL MAGNETIC FIELD. Pekarek, S. (Czech Technical Univ., Prague). Czech. J. Phys.; 21: No. 9, 930-5 (1971).

The behavior of the plasma of a low-pressure toroidal glow discharge in a radial magnetic field is studied experimentally. Results concerning the plasma velocity as a function of the magnetic field for different pressures are given. (auth)

59003 MEASUREMENT OF ATOMIC METASTABLE DENSITIES IN NOBLE-GAS PLASMAS CREATED BY NUCLEAR RADIATIONS. Guyot, Jean Charles. Urbana, Ill.; Univ. of Illinois (1971). 243p. University Microfilms Order No. 71-21,132. Thesis.

Measurement of metastable densities in He, Ne, and He–Ne plasmas is reported. The University of Illinois TRIGA Nuclear Reactor was operated in the pulse mode to provide a source of neutrons to induce ionization and excitation in these gases, via the nuclear reaction $^{10}B(n,\alpha)^{7}Li$ in a boron coating on the walls of the gas container. An optical absorption technique was used wherein a light source illuminated the gas under investigation, which was in a cell placed near the core of the reactor. This cell contained boron-coated aluminum tubes providing the source of heavy charged particles. The amount of the light at a given wavelength traversing the cell was measured during a reactor pulse. These absorption data were interpreted in terms of metastable densities, including a correction due to pressure broadening. The experiments covered a gas pressure range from ~0 to 1000 torr, with neutron fluxes from 10^{12} to 10^{16} n/cm^{-2}-sec. The He(2^1S)- and He(2^3S)-metastable densities in pure helium were studied, as well as the Ne($1s_5$)- and Ne($1s_3$)-metastable densities in pure neon and (9/1) helium–neon mixtures. These results are presented graphically versus gas pressure and neutron flux. Also, a value of the He(2^3S) density equal to 1.5×10^{10} atoms/cm^3 was measured in a (9/1) He–Ne mixture, at a total pressure of 163 torr, for a flux of 4.3×10^{15} n/cm^2-sec. Gain-measurement experiments were conducted at 3.39 and 1.15μ in He–Ne to investigate the possibility of an inversion of population between known laser levels. There appears to be a small gain at both wavelengths (less than 4% per meter), but the present detection technique was not sensitive enough to unambiguously prove its existence. A theoretical model developed describes the transport of heavy-charged particles and the plasma kinetics. In general, this model predicted the behavior of the metastable densities quite well, the largest discrepancy being for the case of the He(2^3S) density in pure He. It would, however, predict a gain at 3.39μ larger than observed experimentally. Gain and absorption experiments in He–Ne at higher pressures (700 to 1000 torr) were hampered by the appearance of an anomalous effect tentatively attributed to the formation of a gas lens due to uneven heating of the high-pressure gas. (Diss. Abstr. Int., B)

59004 COMPUTER SIMULATION OF ELECTRICAL BREAKDOWN IN GASES. Kline, Laurence Earl. Pittsburgh; Carnegie-

Mellon Univ. (1971). 174p. University Microfilms Order No. 71-20,637.

Thesis.

A new method is presented for the simulation of electrical breakdown phenomena, and plasma phenomena where both binary electron–neutral gas molecule collisions and collective interactions among charged particles are important. Elastic, exciting, and ionizing electron–neutral gas molecule collisions are included using a Monte Carlo technique. Electron–ion pairs are released in ionizing collisions. Collective interaction is included using a one-dimensional plasma model that regards the charged particles as charge sheets. Poisson's equation is solved in one dimension based on the positions of the charge sheets to find the accelerating forces on the sheets. The simulation also includes the release of electron–ion pairs by photoionization. The method is used to simulate the growth of electron avalanches and electron streamers in nitrogen-filled parallel plane gaps. Avalanche simulation results are used to calculate values for three transport coefficients: the drift velocity, ionization coefficient, and characteristic energy in nitrogen. The calculated values of the transport coefficients agree with experimental values over a wide range of E/p, the applied electric field divided by the pressure. Velocities for anode- and cathode-directed streamers are calculated based on the streamer simulation results. The calculated streamer velocities agree with available experimentally measured streamer velocities. The streamer simulation results also show that photoionization is an important mechanism in streamer growth. (Diss. Abstr. Int., B)

59005 ARC DISCHARGES IN STRONG MAGNETIC FIELDS. Wienecke, R. (Univ., Stuttgart). pp 687-93 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Thermodynamic properties of an electric arc are discussed. The effects of an external magnetic field on the energy balance in an arc are described. Some experimental results are shown. (M.O.W.)

59006 VACUUM-UV EMISSION OF HIGH-DENSITY PLASMA GENERATED IN WALL-STABILIZED ARC. Mueller, D. (Max-Planck Inst., Munich). pp 694-705 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

A wall-stabilized argon arc for spectroscopic measurements in the vacuum-uv range is described. Temperature measurements and atomic-parameter measurements in the arc are discussed. (M.O.W.)

59007 RELAXATION AND TEMPERATURE DIFFERENCE IN QUASI-LINEAR APPROXIMATION FROM CALCULATIONS OF COLLISIONS FOR MAGNETOACTIVE PLASMA. Machabeli, G. Z. Zh. Prikl. Mekh. Tekh. Fiz.; No. 2, 47-51(Mar-Apr 1969). (In Russian).

Equations for longitudinal waves were obtained in the quasilinear approximation from calculations of collisions for plasma placed in a constant magnetic field. The contribution to the relaxation of temperatures of a two-component plasma as a result of the interaction of waves with resonance particles is obtained. The difference of temperatures of electrons and ions in the steady-state case and also the perpendicular and parallel difference in relation to magnetic field of constituent temperatures for each type of particle in the electric field of the wave are found. (tr-auth)

59008 POPULATION OF EXCITED ATOMIC STATES AND IONIZATION IN A NONEQUILIBRIUM CESIUM PLASMA AT LOW PRESSURE. Chelnokov, M. B. (Moscow Aviation Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 52-6(1969). (In Russian).

The system of nonlinear algebraic equations was obtained for determination of the population of 20 lower levels of cesium in nonequilibrium low-pressure plasma, with consideration of high output from the elementary processes. Solutions for this system were accomplished by computer. Results were compared with experimental results of the literature, and agreement was satisfactory. Results of the solution obtained, besides level populations, were ionization coefficients and concentrations of molecular ions of cesium. It was found that the ionization yield is maximum at the $6P_{1/2}$ level, after which it falls rapidly so that the lower 20 levels give practically all of the ionization yield. Therefore, disregard of the other levels does not introduce errors in calculation of the ionization coefficient. (tr-auth)

59009 GAS DISCHARGES. International Conference Held in London, 15–18 September 1970. Conference Publication No. 70. London; Institution of Electrical Engineers (1970). 599p. (CONF-700969).

122 papers were presented at this conference. Separate abstracts were prepared for eleven of these. (UK)

For abstracts of individual papers see: 57902, 58950, 58999–59001, 59010, 59011, 59022, 59023, 59072, and 59080.

59010 ESTIMATION AND MEASUREMENT OF ELECTRON LOSSES FROM AVALANCHES IN HYDROGEN. Allen, N. L.; Mitchell, P. (Univ. of Leeds, Eng.). pp 53-7 of Gas Discharges. London; Institution of Electrical Engineers (1970).

From International conference on gas discharges; London, England (15 Sep 1970). See CONF-700969.

The situation is discussed in which the breakdown of a plane-paralled gap, in the region of the Paschen minimum, is influenced by the proximity of walls or other surfaces. In particular, electron diffusion loss from an avalanche is considered. An electron avalanche expands by diffusion, and preliminary experiments showed that the resulting absorption of particles by the containing walls leads to an increase in breakdown potential. A model is adopted to calculate particle losses from avalanches, and the results are compared with experimental data obtained by measurement of pre-breakdown currents in a cylindrical tube. This model offers an alternative to the rigorous analytical approach of Lucas (Proc. IEE, 2: 867(1969)). In the experimental work, extensive sets of wall and anode current measurements were made in H_2. (UK)

59011 MERCURY ELECTRON-BOMBARDMENT ION THRUSTERS. King, H. J. (Hughes Aircraft Co., Malibu, Calif.). pp 262-5 of Gas Discharges. London; Institution of Electrical Engineers (1970).

From International conference on gas discharges; London, England (15 Sep 1970). See CONF-700969.

It is stated that ion propulsion has two immediate applications: primary propulsion for unmanned space probes or raising of communication satellites to synchronous orbit; and control propulsion to position or reorientate a satellite with respect to some fixed reference. Details are given of prime propulsion systems and their applications and satellite attitude control and station keeping systems. Two designs of mercury electron-bombardment ion thrusters are described, each having a sufficiently high performance to fulfill requirements for current space missions, and in which the hollow cathode was improved so as to provide electron currents of 10 A or more without showing any visible erosion after 500 hours, and the useful life of which is at least ten times this period. An electrical isolator system was developed to permit all thrusters in an array to be operated simultaneously from a single grounded mercury reservoir without electrical interaction between the thrusters; this is essential to make best use of the mercury propellant whilst still permitting one thruster to sustain an electrical short to ground without making all thrusters inoperative. (UK)

Kinetics (Experimental)

59012 (CEA-CONF-1833) DEFORMATION OF THE ELECTRON DISTRIBUTION FUNCTION UNDER THE INFLUENCE OF A LARGE AMPLITUDE WAVE. Guillemot, M.; Olivain, J.; Perceval, F.; Quemeneur, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1971]. 4p. (CONF-710920–6). Dep. NTIS (U. S. Sales Only).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

The deformation of the electron distribution due to its interaction with a large-amplitude plasma wave is measured and shows good agreement with theoretical predictions. (France)

59013 (CEA-CONF-1835) NONLINEAR HARMONIC GENERATION IN A THERMAL MAGNETIZED PLASMA. Cano, R.; Fidone, I.; Schwartz, M. J.; Zanfagna, B. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1971]. 4p. (CONF-710920–2). Dep. NTIS (U. S. Sales Only).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

An experiment is discussed in which a radiation was observed at the second harmonic of an incident microwave beam. The experimental results are in good agreement with the theory of nonlinear harmonic generation in inhomogeneous plasmas. (France)

59014 ION PRODUCTION AND LOSS PROCESSES IN HELIUM-NITROGEN MIXTURES. Maerk, Tilmann D.; Oskam, H. J.

(Univ. of Minnesota, Minneapolis). Phys. Rev., A: 4: No. 4, 1445-52(Oct 1971).

Detailed studies of the time dependence of the number density of ions were made during the decay period of plasmas produced in He containing various concentrations of nitrogen molecules. Various reaction-rate constants were obtained: He $(2\ ^3S) + N_2 \rightarrow N_2^+ + He + e$ $[(6.3 \pm 1.0) \times 10^{-11}$ cm^3 sec$^{-1}]$; $N_2^+ + N_2 + He \rightarrow N_4^+ + He$ $[(5.3 \pm 0.3) \times 10^{-30}$ cm^6 sec$^{-1}]$ and $N^+ + N_2 + He \rightarrow N_3^+ + He$ $[(4.6 \pm 0.4) \times 10^{-29}$ cm^6 sec$^{-1}]$. Evidence for the charge-transfer process $N_2^+ + N \rightarrow N^+ + N_2$ was obtained. The values of the ambipolar-diffusion coefficients of nitrogen ions in He were found to be $D_ap_0(N^+) = 970 \pm 50$; $D_ap_0(N_2^+) = 920 \pm 40$, and $D_ap_0(N_3^+) = 840 \pm 70$ cm^2 sec^{-1} torr, while the diffusion coefficient of He $(2\ ^3S)$ was $D_mp_0 = 480 \pm 30$ cm^2 sec^{-1} torr. (auth)

59015 ROLE OF RECURRING DISCHARGE IGNITION IN A DYNAMIC Z PINCH. Kvartskhava, I. F.; Matveev, Yu. V. (Physical-Technical Inst., Sukhumi, USSR). Nucl. Fusion; 11: No. 4, 385-7(Aug 1971).

Several of the unexplained properties of a dynamic z pinch are considered. The singularities observed when there are distinct breaks in the voltage and discharge current oscillograms are analyzed. The m = 0 instability and the processes occurring at the electrodes of the pinch are then discussed. (M.O.W.)

59016 PROPERTIES OF DENSE HELIUM PLASMA IN RECOMBINATION STAGES. Razmadze, N. A.; Chkuaseli, Z. D.; Sholin, G. V. Zh. Prikl. Spektrosk.; 14: No. 1, 30-3(Jan 1971). (In Russian).

The contours and intensity of the spectral lines of He II 4686 Å and He I 4471 Å were measured in a collapsing helium arc formed by means of an electrodeless pulse discharge of average power. The electron concentration was accordingly calculated to be between 10^{17} and 10^{16} cm^{-3}, the temperature 6 to 1 eV. The estimate of the recombination coefficient (10^{-12} to 10^{-11} cm^3/sec) supports the impact-radiative mechanism of plasma decay. (tr-auth)

59017 PLASMA PARAMETERS AND THE POPULATION OF EXCITED ATOMIC STATES IN A LOW-CURRENT HELIUM ARC. Gol'dfarb, V. M.; Il'ina, E. V.; Kasakov, A. I. Zh. Prikl. Spektrosk.; 14: No. 1, 34-6(Jan 1971). (In Russian).

A plasma column of a helium arc (10 A) was used at atmospheric pressure. The temperature of the atoms and electrons on the discharge axis was about 7,000 and 15,000°K. The concentration of the electrons, determined by the broadening of the H_β line of He, was 8×10^{14} cm^{-3}. The population of the upper levels of He was noticeably smaller than equilibrium. The distribution temperature, determined by the relative population levels ($n_1/n_2 = 3/4$; $3/5$), was close to gas temperature. Possible causes of a significant non-equilibrium of the plasma are discussed. (tr-auth)

59018 INTERACTION OF ARGON AND NEON PLASMAS IN PSEUDO EQUILIBRIUM WITH ADDITIONS. Czernichowski, A. (Ecole Polytechnique, Wroclaw). Acta Phys. Pol.; A40: No. 3, 309-13(Sep 1971). (In French).

Experiments were carried out on the interaction of plasmas of argon or neon in pseudo equilibrium with nitrogen, oxygen, hydrogen, helium, neon, carbonic gas, and pentane. Spectroscopic observations show the role of the metastable states as well as the role of the resonance radiation in the establishment of equilibria in argon or very pure neon plasma. The reduction of the argon or neon plasma in pseudoequilibrium with a local thermodynamic equilibrium state can be made with the help of additions having quantum or continuous internal energy states situated near resonance levels or near metastable levels of the principal components of the plasma. (tr-auth)

59019 PRODUCTION AND LOSS OF N_2^+, Ne^+ AND Ne_2^+ DURING THE DECAY PERIOD OF PLASMAS PRODUCED IN NEON–NITROGEN MIXTURES. Maerk, Tilmann D. (Univ., Innsbruck); Oskam, H. J. Z. Phys.; 247: No. 1, 84-94(1971).

Studies of the time dependencies of the number density of N_2^+, Ne^+, and Ne_2^+ ions were made during the decay period of plasmas produced in neon containing various concentrations of nitrogen molecules. Reaction rate constants were obtained for $N_2^+ + N_2 + Ne \rightarrow N_4^+ + Ne$ $((1.2 \pm 0.2) \times 10^{-29}$ cm^6 sec$^{-1})$ and $Ne^+ + N_2 \rightarrow N_2^+ + Ne$ $((2.9 \pm 0.3) \times 10^{-12}$ cm^3 sec$^{-1})$. The ambipolar diffusion coefficient of N_2^+ in neon was found to be $D_ap_0 = 350 \pm 20$ cm^2 sec^{-1} torr. (auth)

59020 EVOLUTION OF TURBULENT ELECTROSTATIC SHOCKS. Wong, A. Y.; Means, R. W. (Univ. of California, Los Angeles). Contract AT(11-1)-34. Phys. Rev. Lett.; 27: No. 15, 973-6(11 Oct 1971).

Turbulent low-Mach-number electrostatic ion shocks are observed when ion reflections ahead of shocks are controlled by new methods. The spatial growth of the turbulence is mapped by a test-wave method and correlated with the distribution of reflected ions. Disagreements with computer experiments are explained. (auth)

59021 HIGH-TEMPERATURE ELECTRON PLASMA BY SLOW MIRROR THETA PINCH. Shiina, Syoiti; Ohnishi, Haruyuki; Murata, Hideo; Sato, Kazuo; Mashiba, Tadashi (Tokyo Coll. of Science and Engineering). Kakuyugo Kenkyu; 26: No. 2, 93-111(Mar 1971). (In Japanese).

The hot electron plasma of 50- to 80-keV average energy is produced by the slow theta-pinch helium discharge and confined in the magnetic mirror field (mirror ratio 1:1.48). The density of the confined plasma ($\gtrsim 10^{13}$/cm^3) is higher than that of the plasmas produced by other methods of the hot electron plasma production. The confinement time is about 200 μsec; this value can be explained by the multiple scatterings of the hot electrons with neutral atoms. The plasma column is a little deformed, but the deformation does not grow during 200 μsec. During the low-density phase in the discharge, a burst of hot electrons is observed across the magnetic lines of force. The radial burst occurs at the midplane of the mirror field, and is not observed at the mirror plane. The time of the occurrence of the burst depends sensitively on the initial gas pressure or cold electron density. The radial burst arises from the flute-type instability, which is conditioned by the cold-to-hot density ratio. The axial loss of hot electrons along the magnetic lines of force is also observed independently of the radial burst and independently of the initial gas pressure. The axial burst is composed of hot electrons with energies below 90 keV. The energy distribution of escaping hot electron flux shows a non-Maxwellian distribution, which does not significantly change before and after the burst. The burst is observed in the plasma condition $\omega_{pe}/\omega_{ce} \lesssim 1$. The buildup time of the burst is a few microseconds, much greater than that of the radial burst. The mechanisms of axial burst are discussed. (auth) (Japan)

59022 INITIATING AN INTENSE DISCHARGE PLASMA AT VERY LOW GAS PRESSURES WITH THE HELP OF AN AUXILIARY DISCHARGE. Chandraker, K. (Univ. of Salford, Eng.). pp 58-62 of Gas Discharges. London; Institution of Electrical Engineers (1970).

From International conference on gas discharges; London, England (15 Sep 1970). See CONF-700969.

An experimental investigation is described with a view to producing a plasma of high degree of ionization at gas pressures of 10^{-6} to 10^{-3} torr. Difficulties arise in starting an electrical discharge under vacuum conditions, and various methods were devised with a view to overcoming this. In the experiment described an auxiliary discharge was first started between one of the main electrodes and an auxiliary electrode located in the vicinity of the former and a voltage then applied between the main electrodes to initiate an intense electrical discharge. Most of the preliminary observations were made with H_2, but He and Ne were subsequently used to ascertain whether the nature of the gas had any effect on development of the discharge. Details are given of the development of the auxiliary and main discharges. (UK)

59023 PROPERTIES OF A HIGH-CURRENT DISCHARGE IN ALKALI-METAL-SEEDED RARE GASES. Ellington, H. I. (Robert Gordon Inst. of Tech., Aberdeen, Scotland); Dunn, P. D. pp 313-17 of Gas Discharges. London; Institution of Electrical Engineers (1970).

From International conference on gas discharges; London, England (15 Sep 1970). See CONF-700969.

The discharge described is stated to have potential applications in the field of closed-cycle magnetohydrodynamic power generation, and shows some unusual features that make it of considerable scientific interest. It carries a current of the order of amps between plane-metal electrodes immersed in atmospheric-pressure He, Ne, or Ar at 800 to 1250°K to which a small quantity of Cs, K, or Na vapor is added as an easily ionized seed, and operates at an applied voltage of a few volts or tens of volts when the electrode spacing is a few mm or cm, respectively. It appears to consist of two distinct regions—a thin highly luminous sheath covering the entire cathode surface and a brightly glowing cylindrical positive column extending from the anode surface to within a mm or so of the cathode surface, diverging and becoming fainter as it nears the latter. The two luminous regions are separated by a narrow but clearly visible dark space. The interelectrode potential drop also consists of two distinct parts— a sharp voltage drop immediately in front of the cathode surface, and a uniform drop along the positive column. The process by which the discharge is initiated is first examined, followed by an examination of the discharge itself, dealing in turn with the cathode regions and positive column. (UK)

XUM

59024 FINE STRUCTURE OF THE DISTRIBUTION FUNCTION OF IONS IN THE PLASMA OF A STRONG-CURRENT z DISCHARGE. Gosteva, T. S.; Fedyakov, V. P. JETP Lett. (USSR) (Engl. Transl.); 14: No. 3, 103-5(5 Aug 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 3, 158-60(5 Aug 1971).

The spectra of ions leaving the plasma of a strong-current z discharge along the field through the mirrors, and also of the neutrals leaving in a direction transverse to the field were studied. The experimental conditions were: discharge current 20 to 40 kA, plasma diameter ~7 cm, longitudinal field $H_0 \sim 2kOe$, initial hydrogen pressure in the chamber $p \sim 10^{-4}$ to 6×10^{-3} mm Hg. (M.O.W.)

Kinetics (Theoretical)

Refer also to abstract 59556.

59025 (CEA-CONF-1832) ACCESSIBILITY OF EXACT NONLINEAR STATIONARY STATES IN WATER-BAG MODEL COMPUTER EXPERIMENTS. Finzi, U. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1971]. 4p. (CONF-710920-5). Dep. NTIS (U. S. Sales Only).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

The initial configuration was assumed to be a uniform state which has the same constants of motion as a Bernstein–Greene–Krushal (BGK) periodic stationary state, and an initial perturbation of finite amplitude and whose wavelength is equal to the periodicity length of this stationary state was applied to it. Computer experiments showed that the system starts its evolution thanks to nonlinear instability and reaches, within a few plasma periods, the exact nonlinear BGK equilibrium expected. (France)

59026 (CEA-CONF-1834) ELECTRON CORRELATIONS IN UNIFIED LINE SHAPES. Capes, H.; Voslamber, D. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1971]. 4p. (CONF-710920-3). Dep. NTIS (U. S. Sales Only).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

Electron correlations were introduced in the unified model for Stark broadening by electrons. (France)

59027 (IPP-6/94) ON THE VALIDITY OF THE QUASI-LINEAR APPROXIMATION FOR TURBULENT PLASMAS. Biskamp, D.; Welter, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Mar 1971. 41p. Dep. NTIS (U. S. Sales Only).

Theoretical conditions for applicability of the quasi-linear theory (QLT) are formulated. To investigate the importance of these conditions, numerical experiments are performed on two different types of weak one-dimensional plasma instabilities. It is found that the behavior of the bump-in-tail instability is consistent with QLT (saturation field energy $\langle \hat{\mathcal{E}} \rangle / \gamma \pi n T \sim$ linear growth rate γ) if these conditions are satisfied, while in the opposite case, trapping stabilization is important (trapped particle bound frequency $\omega_b \sim \gamma$). The weak symmetric two-stream instability never satisfied the criterion for validity of QLT, since all particles that are supposed to diffuse are trapped ($\Delta v_{diff} \sim \Delta v_{trap}$). Incidentally, however, the first saturation level predicted by QLT is the same as given by the condition for trapping stabilization, $\omega_b \sim \gamma$. The important deviation in this case from weakly turbulent behavior is apparent from the coherent-mode coupling process, which becomes (relatively) stronger, the weaker the instability. (auth)

59028 RELAXATION OF DIFFERENCE BETWEEN ION AND ELECTRON TEMPERATURES IN A PLASMA. Aono, Osamu; Tange, Toshio (Tokyo Univ.). J. Phys. Soc. Jap.; 31: No. 4, 1234-6(Oct 1971).

The relaxation rate is obtained on the basis of the unified theory. When the ion temperature is of the same order of magnitude as the electron temperature, the effective screening length of the interaction is the electron Debye length. As the ion temperature decreases, the effective screening length decreases. The low ion-temperature asymptote is obtained. Numerical values are given graphically. (auth)

59029 VISCOSITY COEFFICIENTS OF A PLASMA IN A STRONG MAGNETIC FIELD: APPLICATION OF THE QUANTUM MECHANICAL UNIFIED THEORY. Kaneko, Shobu (Univ. of Tennessee, Knoxville). J. Phys. Soc. Jap.; 31: No. 4, 1240-5(Oct 1971).

The Coulomb logarithm for the viscosity coefficient of a plasma in a magnetic field is determined exactly by the quantum-mechanical unified theory. The magnetic field is assumed so strong that the condition, Debyelength ≪ ion gyration radius ≪ mean free path, is satisfied. For a hydrogenic plasma, the quantum correction to the Coulomb logarithm can not be neglected if the temperature is higher than 10^6 K. (auth)

59030 PENETRATION OF FAST HYDROGEN ATOMS INTO A FUSION REACTOR PLASMA. Riviere, A. C. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nucl. Fusion; 11: No. 4, 363-9(Aug 1971).

The depth of penetration of fast hydrogen atoms into a fusion reactor plasma, before they become ionized and held by the magnetic field, is of importance in connection with the heating and refueling of such a plasma. Here, the experimental cross sections for the important collision processes are reviewed, and analytic expressions are formed that describe the data reasonably well. The ion and electron energy distributions to be expected in both toroidal and mirror reactors are used, with the analytic expressions for the cross sections, to calculate rate coefficients. The plasma thickness T for an 1/e reduction in intensity of the atom beam is then obtained as a function of beam energy and plasma temperature over the range 0.1 to 2000 keV (D^+, D^0). As an example, a 1-MeV deuterium atom beam entering a toroidal reactor plasma has $T = 1.7 \times 10^{16}$ and 2.5×10^{16} cm^{-2} for plasma temperatures of 1 and 100 keV, respectively. (auth)

59031 NEUTRAL-GAS ACCELERATION BY AN ELECTROMAGNETIC PLASMA GUN. Pert, G. J. (Univ. of Alberta, Edmonton). Nucl. Fusion; 11: No. 4, 371-5(Aug 1971).

It has recently been found (Pert, 1970) that an un-ionized shock wave is formed during the early discharge in a parallel-plate rail gun. Using this result it is possible to accelerate neutral gas to high velocities with a low ionization level. A system utilizing this principle is proposed to accelerate neutral gas to high velocity. An analysis of the proposed system is presented. (auth)

59032 FRANCK–CONDON PRINCIPLE AND BROADENING OF ISOLATED SPECTRAL LINES IN PLASMAS. Szudy, J. (Nicholas Copernicus Univ., Torun, Poland). Acta Phys. Pol.; A40: No. 3, 361-361-78(Sep 1971).

The role of the Franck–Condon principle in the description of the pressure broadening of isolated spectral lines is investigated on the basis of the Jabłoński theory. Expressions for the correlation function of this theory are derived both in the semiclassical approximation as well as in a general way. First it is shown that the quasi-static Margenau–Holtsmark theory of line broadening follows from that of Jabłoński in the asymptotic case of heavy perturbers when the classical form of the Franck–Condon principle can be applied. On the other hand, the results of quantum-mechanical impact theory of line broadening due to electrons are re-derived under assumptions analogous to those used in the theories of scattering processes. For the nonspherically symmetrical interactions, a general expression for the line shape is given that is in a close analogy with that derived on the basis of the resolvent operator technique. (auth)

59033 MEASUREMENTS OF COLLISION AND HEATING TIMES IN A TWO-DIMENSIONAL THERMAL COMPUTER PLASMA. Hockney, R. W. (IBM Watson Research Center, Yorktown Heights, N. Y.). J. Comput. Phys.; 8: No. 1, 19-44 (Aug 1971).

The nearest grid point (NGP) and the cloud in cell (CIC) particle models of a plasma were studied, together with two other models obtained from the above by smoothing the potential before use (HNGP and HCIC models). The collision time is found to be only slightly dependent on the model and is given to 20% by $(\tau_{coll}/\tau_{pe}) = n(\lambda_{D^2} + W^2)$, where n is the density and W the width of the particles (W = H, the mesh spacing for NGP and CIC; W = 2H for HNGP and HCIC). The ratio of electric-field energy to particle energy is given by $\langle \mathcal{E}^2 \rangle / 8\pi \div nmv_{th}^2 = 0.12/n(\lambda_{D^2} + W^2)$. Stochastic heating due to the finite size of the space mesh and the time step DT is correlated as a function of H/λ_D and $\omega_{pe}DT$. An optimum path in this parameter plane is found to be $(\omega_{pe}DT)_{opt} = \min[\tfrac{1}{2}H/\lambda_D, 1]$. On this path the ratio of the heating time (the time for the average kinetic energy of an electron to increase by $\tfrac{1}{2}kT$) to the collision time is $(\tau_H/\tau_{coll}) = K_2/(H/\lambda_D)^2$, where K_2 = 2.1(NGP), 6.4 (HNGP), 41 (CIC), 200 (HCIC). The models are compared on the basis of the cost in computer time per square collisionless plasma period per mesh cell. If we permit computing provided $(\tau_H/\tau_{coll}) > 10$ (or better than 2.5% energy conservation in a collision time) then the most economic model to use is given by the table: 0 ← NGP → 0.45 ← HNGP → 0.8 ← CIC → 2.0 ← HCIC → 4.5, where the name of the model is written between the values of H/λ_D for which it is best suited. Alternatively, if one accepts a model provided

$(\tau_H/\tau_{coll}) > 1$ (or better than 25% energy conservation in a collision time), then the favored ranges for the different models are $0 \leftarrow$ NGP $\rightarrow 1.5 \leftarrow$ HNGP $\rightarrow 2.5 \leftarrow$ CIC $\rightarrow 6.5 \leftarrow$ HCIC $\rightarrow 14$. None of the models considered may be used for $H/\lambda_D > 14$. (auth)

59034 DETERMINATION OF PARAMETERS OF NONEQUILIBRIUM PLASMA IN A RESTRICTED VOLUME ALLOWING FOR STEP-WISE IONIZATION. Gavryushenko, B. S.; Latyshev, L. A.; Chelnokov, M. B. Zh. Prikl. Spektrosk.; 14: No. 3, 389-92(Mar 1971). (In Russian).

The population of excited levels and the contribution of these levels in ionization were determined, allowing for a large number of elementary processes including photon absorption. A system of equations and their solution were obtained for a non-equilibrium, low-pressure plasma for a Maxwell electron distribution. The calculated results agree with experimental data. The maximum contribution in the ionization of cesium gives the level $6P_{1/2}$ over a broad range of plasma parameters. (tr-auth)

59035 CATHODE SHEATH IN A DISTRIBUTED MAGNETOPLASMA WITH INTERACTIONS BETWEEN PLASMA PARTICLES AND THE CATHODE. Minyatov, A. V.; Pankratov, V. G. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 583-8(Oct 1971).
Translated from Zh. Tekh. Fiz.; 41: No. 4, 744-51(Apr 1971).

A solution of Maxwell's equations for the electric field E is used to obtain a relationship between the electric field at the cathode surface, which enters into the Schottky correction to the Richardson formula, and the potential drop in the cathode sheath. A current balance equation is used to determine the voltage–current characteristics. Results of the computations are presented. (auth)

59036 RADIAL DISTRIBUTION OF RADIATION INTENSITY IN AXISYMMETRIC DENSE PLASMA. Ambrok, G. S. Zh. Prikl. Spektrosk.; 14: No. 3, 383-8(Mar 1971). (In Russian).

An analytical scaling method is proposed for approximating the transverse integral intensity distribution according to the radius in an axially symmetric dense plasma. The approximation is included in a substitute for the absorption coefficient, which becomes an integral equation of the first order, by its average value. The Laplace transform is used to solve the integral equation. For transparent media, the solution leads to a solution of Abel's equation, which holds valid for optical transparency of over 80%. For denser plasmas, a solution of the general equation is necessary. (tr-auth)

59037 NONLINEAR THEORY OF PLASMA MOTION IN A HIGH-FREQUENCY ELECTROMAGNETIC FIELD. Vas'kov, V. V.; Karpman, V. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 529-32(Oct 1971).
Translated from Zh. Tekh. Fiz.; 41: No. 4, 676-9(Apr 1971).

The nonlinear motion of a nonisothermal plasma is considered in a strong high-frequency electromagnetic field due to traveling TE waves. The general properties of solitary and periodic waves are investigated. (auth)

59038 INHERENT MAGNETIC FIELD IN THE POSITIVE COLUMN. Belousova, L. E. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 524-8(Oct 1971).
Translated from Zh. Tekh. Fiz.; 41: No. 4, 669-75(Apr 1971).

An approximate solution is obtained for the electron balance equation by means of Galerkin's method in a stationary positive column; account is taken of the inherent magnetic field for direct and stepwise ionization. The effect of the charged particle density at the boundary on the distribution curve is considered. An approximate solution is found which takes into account the inherent magnetic field and Coulomb collisions. An expresssion is obtained for the electron equilibrium distribution under the effect of the inherent magnetic field and Coulomb collisions. (auth)

59039 ANOMALOUSLY LARGE SCATTERING BY A TURBULENT, WEAKLY IONIZED PLASMA. Bugnolo, Dimitri S. Phys. Rev. Lett.; 27: No. 16, 1042-4(18 Oct 1971).

An anomalously large result is predicted in the first Born approximation for the scattering cross section of a turbulent, weakly ionized plasma for the case when $\omega > \omega_p$, $\nu_{en} > \omega_p$, and $\omega \sim \nu_{en}$. (auth)

59040 NUMERICAL INTEGRATION METHODS OF THE VLASOV EQUATION. Joyce, Glenn (Univ. of Iowa, Iowa City); Knorr, Georg; Meier, Homer K. Contract AT(11-1)-2059. J. Comput. Phys.; 8: No. 1, 53-63(Aug 1971).

The methods of integrating the nonlinear Vlasov equation are reviewed, compared, and interrelations are investigated. Another method is given that allows a truncation of the resulting infinite matrix without causing numerical instabilities. Its application to the linear and nonlinear Vlasov equation is discussed. It is shown that the cause for numerical instability is based on approximating a continuous eigenvalue spectrum by a discrete spectrum. (auth)

59041 APPLICATION OF THE GENERALIZED NEWTON–RAPHSON METHOD IN RADIATIVE-TRANSFER PROBLEMS. Skumanich, A.; Domenico, B. A. (National Center for Atmospheric Research, Boulder, Colo. Univ. of Colorado, Boulder). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 547-57(Jun 1971).
From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

The simultaneous excitation and transfer of radiation in a plasma gives rise to nonlinear operator equations for the atomic occupation numbers. An iterative method for solving such equations, based on a generalized Newton–Raphson scheme, is described and applied to the problem of the formation (under the condition of complete redistribution) for a resonance emission line interacting with two associated subsidiary lines (the three-level atom or ($L\alpha$, $L\beta$, $H\alpha$) problem). (auth) (UK)

59042 EFFECTIVE POTENTIALS BETWEEN THE COMPONENTS OF A HYDROGENEOUS PLASMA. Barker, A. A. (Univ. of Florida, Gainesville). J. Chem. Phys.; 55: No. 4, 1751-9(15 Aug 1971).

Two-particle "effective potentials," which incorporate the quantum mechanical effects into the pair interaction potential, are evaluated accurately. Tables and graphs of these potentials between electron–proton, parallel spin electron–electron, antiparallel spin electron–electron, and proton–proton are presented for a wide range of temperatures. The range of validity and analytic properties of the effective potentials in certain regions are given. Possible uses of these potentials to evaluate thermodynamic properties and percentage ionization of the plasma are discussed. (auth)

59043 DETONATION WAVES IN RELATIVISTIC MAGNETOHYDRODYNAMICS. Cissoko, M. Compt. Rend., Ser. A; 273: No. 1, 54-7(5 Jul 1971). (In French).

The Lichnerowicz formalism is applied to the study of the general properties of detonation waves in relativistic magnetohydrodynamics. The classical results are generalized in both general and special relativity. (France)

59044 HIGH-MACH-NUMBER TURBULENT MAGNETOSONIC SHOCKS. Papadopoulos, K.; Wagner, C. E.; Haber, I. (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 27: No. 15, 982-6(11 Oct 1971).

High-Mach-number turbulent magnetosonic shocks caused by driving a purely reflecting piston into a plasma were simulated using an electromagnetic particle code. A physical analysis of the results is presented, together with scaling arguments and comparisons with experimental data. (auth)

59045 BREMSSTRAHLUNG POWER DENSITY: SEMICLASSICAL CALCULATIONS. Modesitt, G. E. (Rand Corp., Santa Monica, Calif.). Phys. Rev. Lett.; 27: No. 15, 971-3(11 Oct 1971).

Quantum limitations on classical bremsstrahlung calculations are discussed. It is shown that the minimum impact parameter for low-energy ($\lesssim$13-Ev) electrons is $\sim(e^4\hbar/m^3v^5)^{1/3}$. Oppenheim's results, purporting to show that the power radiated in a plasma is greater than previously predicted, are explained and shown to be invalid. (auth)

59046 ELECTRICAL CONDUCTIVITY IN TOROIDAL PLASMA WITH TRAPPED PARTICLES. Daybelge, Umur (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 27: No. 14, 916-19(4 Oct 1971).

The electrical conductivity in a toroidal plasma was calculated, using the exact Fokker–Planck operators for electron–electron and electron–ion collisions. It is found that the nonlinear effects of the electron–electron operator are of order r/R, where r and R are the minor and major radii of a flux surface. The conductivity can be written as $\sigma = \sigma_{Spitzer} [1 - \frac{3}{2}(r/R)^{1/2} + O(r/R)]$. (auth)

59047 MIXED THREE-DIMENSIONAL FLOWS OF GAS IN LONGITUDINAL MAGNETIC FIELDS. Gorskii, V. B. Zh. Prikl. Mekh. Tekh. Fiz.; No. 2, 34-7(Mar-Apr 1969). (In Russian).

Spatially mixed flows of gas with infinite conductivity in a longitudinal magnetic field are considered. By the method of small perturbations, approximate equations are found of the magnetic potential of velocity of perturbation for all of the possible mixed flows; also, certain special integrals were obtained. (tr-auth)

XUM

59048 STEADY-STATE DISTRIBUTION OF CHARGED PARTICLES IN THE DIFFUSION APPROACH. **Aleksandrov, A. F.; Ambaryan, S. S.; Mitsuk, V. E.; Pogosyan, V. A. Zh. Prikl. Mekh. Tekh. Fiz.; No. 2, 61-6(Mar-Apr 1969). (In Russian).**

The problem concerning the steady-state density distribution of charged particles in weakly ionized plasma is examined in the presence of processes of volumetric ionization, recombination, and diffusion in space-charge fields. The solution of balance equations of charged particles together with Poisson equations for the case of a plane, cylindrical configuration of plasma are obtained, satisfying the Schottky condition at the boundaries of the region. The solution of the problem is also found when the ionization process is localized in the spherically symmetric volume, and the Schottky condition is realized to infinity. The conditions for existence of the steady state and analysis are adduced. (tr-auth)

59049 EXPANSION IN VACUUM OF RAREFIED PLASMA WITH IONS OF TWO TYPES. **Gefter, V. M. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 32-8(Jan-Feb 1970). (In Russian).**

One-dimensional expansion in the vacuum of multi-temperature plasmas with two varieties of ions was studied. In plasma with a Maxwellian ion velocity distribution, wave propagation at reduced pressure was noted, the boundary of which is a weak discontinuity that moves with the velocity of the ion sound in the plasma. The magnitude of this velocity was found. The first two moments of the distribution function were found. The approximate asymptotic solution of the system of transport equations was obtained in the case of closeness of mass of both varieties of ions; their numerical solution was done by computer. (tr-auth)

59050 DIELECTRIC PERMITTIVITY OF A WEAKLY IONIZED PLASMA PLACED IN CROSSED FIELDS. **Cristea, M. Stud. Univ. Babes-Bolyai, Ser. Phys.; 16: No. 1, 29-46(1971). (In Rumanian).**

The dielectric permittivity of a weakly ionized plasma situated in crossed fields $\vec{E}_0$ and $\vec{B}_0$ was determined. The homogeneous infinite plasma is described by an integral kinetic equation of the BGK collision type. Only the case in which the wave vector of the perturbation is located in the plane determined by the vectors $\vec{E}_0$ and $\vec{B}_0$ was studied. (tr-auth)

59051 APPROXIMATION METHOD OF CALCULATION OF THE BOUNDARY LAYER OF DUAL-TEMPERATURE PLASMAS ON ELECTRODES AT HIGHER VALUES OF THE HALL PARAMETER. **Kalikhman, L. E. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 44-52(Jan-Feb 1970). (In Russian).**

Processes that occur in the boundary layer of plasma on electrodes are described by a complex system of differential equations with boundary conditions specified on two boundaries. Approximation methods for calculating boundary processes are discussed. (tr-auth)

59052 EIGENVALUE PROBLEMS FOR LAGRANGIAN SYSTEMS. V. **Barston, E. M. (New York Univ., N. Y.). J. Math. Phys. (N. Y.); 12: No. 9, 1867-72(Sep 1971).**

Sufficient conditions for exponential instability are obtained for a class of infinite-dimensional gyroscopic Lagrangian systems. Applications are made to the problems of the stability of a rotating thin annular elastic disk and the stability of the steady flow of a one-dimensional warm electron plasma. (auth)

59053 POLYNOMIAL EXPANSION METHOD FOR PROBLEMS INVOLVING A RELATIVISTIC MAXWELLIAN DISTRIBUTION. **Nishimura, Keiichi (Univ. of California, Livermore). J. Math. Phys. (N. Y.); 12: No. 9, 1840-5(Sep 1971).**

With the aim of extending the Sonine polynomial expansion method to the region of relativistic Maxwellian distribution functions, a new set of polynomials is introduced in terms of their orthogonality equation. Their coefficients are derived and tabulated as functions of the temperature for several lower orders. (auth)

Production

59054 (MATT-782) USE OF LONG-WAVELENGTH, HIGH-POWERED LASERS FOR CONTROLLED THERMONUCLEAR FUSION. **Dawson, J. M.; Kidder, R. E.; Hertzberg, A. (Princeton Univ., N. J. Plasma Physics Lab.). Sep 1971. Contract AT(30-1)-1238. 38p. Dep. NTIS.**

The possibilities for applying low-frequency lasers, in particular the 10-μ CO_2 laser, to the problem of controlled thermonuclear reaction are discussed. The 10-μ CO_2 laser can be effective for heating plasmas in the density range of 10^{17} to 10^{19} up to a temperature of several keV. If enough passes of the beam through the plasma can be achieved, effective heating at densities as low as 10^{16} might occur. The development of powerful lasers for 100-μ radiation would make this a definite possibility. It appears that such a laser is a very versatile tool for producing plasma, and many possible plasma configurations can be evisioned. A number of possible fusion devices are presented. These merely represent examples of what might be considered, and are intended to give some feeling for what is possible. Possibilities both for full-scale working reactors and for doing significant experiments today are discussed. (auth)

59055 PRODUCTION OF A VERY QUIESCENT PLASMA IN SKIPPING MAGNETIC FIELDS. **Goede, A.; Brakenhoff, G. J.; Hopman, H. J.; Massmann, P. (FOM-Instituut voor Atoom-en Molecuulfysica, Amsterdam). Phys. Rev. Lett.; 27: No. 16, 1044-7(18 Oct 1971).**

A very quiescent helium plasma, with density fluctuations of less than 0.2%, is produced by applying the stabilizing field of permanent magnets. The steady-state plasma column created in this field, which is of the average minimum-B type, not only proves to be extremely quiescent but also has a homogeneous density distribution in the axial direction ($\Delta n/n\Delta z \approx 2 \times 10^{-3}$ cm^{-1}). The plasma has a density of 5×10^{10} cm^{-3}; the electron temperature is about 7 eV. (auth)

59056 HIGH DENSITY θ-PINCH PLASMA PRE-IONIZED BY THE SHOCK WAVE. **Takeda, Susumu; Funahashi, Akimasa; Kando, Masashi; Makihira, Tsuneichi (Nagoya Univ., Japan). Jap. J. Appl. Phys.; 10: No. 10, 1470(Oct 1971).**

Radio-frequency discharges and shock waves for pre-ionization of a theta-pinch plasma were compared. Diagrams showing the results are given. (M.O.W.)

59057 LASER LIGHT FOR FUSION FIRE. **Basov, Nilolai; Krokhin, Oleg (Lebedev Inst. of Physics, Moscow). New Sci. Sci. J.; 51: No. 771, 733-4(30 Sep 1971).**

Pulsed thermonuclear reactors would remove some of the containment problems of continuous reactors, but such devices need powerful pulsed heating systems. High-power lasers may be ideal for this. Soviet scientists claim to have already achieved laser-induced fusion in a plasma. (UK)

59058 APPLICATIONS OF LASER-PRODUCED PLASMA TO CONTROLLED THERMONUCLEAR FUSION. **Martellucci, S. (Laboratori Gas Ionizzati, Frascati, Italy). Energ. Nucl. (Milan); 18: No. 10, 541-54(Oct 1971).**

Applications of lasers to controlled thermonuclear fusion are reviewed, along with practical feasibility considerations. The physical processes of plasma ionization, heating, and dynamics are described, and particular emphasis is given to plasma production by lasers from solid materials. The conditions for obtaining a pulsed fusion reactor of unitary efficiency are defined as a function of energy and time emission characteristics of the laser source; the requirements for such a source in order to trigger the propagation of the thermonuclear reaction process into a fusionable material are also given. Finally, the present and prospective research programs in Italy and abroad are mentioned. (auth)

59059 CALCULATION OF THE CHARACTERISTICS OF STABILIZED ELECTRIC ARC HEATING OF GASES AT HIGH PRESSURES. **Suksov, I. I.; Levin, M. P. Izv. Sib. Otd. Akad. Nauk SSSR, Ser. Tekh. Nauk; No. 13, 100-5(Oct 1969). (In Russian).**

During electric-arc heating of gases in plasmatrons, the role of radiation increases strongly with increased pressure. This complicates the cooling of electrodes in experiments, and difficulties appear in theoretical results (from complexity of mechanism of radiation transport) associated with calculation of the fraction of radiation in the overall energy balance. Here, relationships are adduced for calculation by the method of successive approximations of electric and thermal characteristics during stabilized (asymptotic) heating of gas from electric arc columns in spherical channels, with radiation calculations. A simplified method is proposed for estimating the effect of radiation on the basis of data on the degree of blackness of plane-parallel layers or hemispherical volumes. Calculational results for air are given. (tr-auth)

Stability

Refer also to abstracts 58900 and 59102.

59060 (CEA-CONF-1800) DISSIPATIVE INSTABILITY ASSOCIATED WITH ELECTRONS TRAPPED IN TOKAMAK-TYPE CONFIGURATIONS. Adam, J. C.; Laval, G.; Pellat, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1971]. 3p. (In French). (CONF-710527-1). Dep. NTIS (U. S. Sales Only).

From Physics conference; Evian, France (25 May 1971).

The influence of collisions on a localized instability due to trapped electrons in a toroidal configuration is studied. It is assumed that the frequency of the instability is greater than the ion bounce frequency but lower than the electron frequency. (auth)

59061 (CEA-CONF-1828) ELECTROSTATIC INSTABILITIES IN A TWO-COMPONENT ANISOTROPIC PLASMA. Jacquinot, J.; Leloup, C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1971]. 4p. (CONF-710920-8). Dep. NTIS (U. S. Sales Only).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

Anisotropy driven electrostatic instabilities near the electron cyclotron frequency and its harmonics seem to play an important role in hot electron plasmas confined in a mirror geometry. In all the experiments that exhibit this instability, a cold plasma coexists with the hot population, the ratio of the cold to the hot densities varying between 1 and 100. The growth rate and marginal stability conditions were calculated, taking into account the cold plasma effects. Numerical solutions are given for an anisotropy ratio $\theta = 8$. (France)

59062 (IPP-6/97) ASYMPTOTIC BEHAVIOR OF THE TWO-STREAM INSTABILITY. Biskamp, D.; Chodura, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jun 1971. 15p. Dep. NTIS (U. S. Sales Only).

Some theoretical ideas are investigated to better understand the results of numerical simulations of the one-dimensional two-stream instability. The observed relation $v_{drift} = v_{the}$ implies a principle of maximum dissipation. On a microscopic level it is shown that the quasi-linear solution is inconsistent with $v_{drift} = v_{the}$, and the assumption of an adiabatically growing BGK wave can not explain the observed similarity behavior. It is proposed that the anomalous resistivity be due to an instability of a BGK wave. Speculations on the multi-dimensional case are made in connection with preliminary results of two-dimensional computations. (auth)

59063 (NP-19031) HIGH-FREQUENCY RESONANT PLASMA. Moisan, M. (Paris Univ., Orsay (France). Laboratoire de Physique des Plasmas). May 1971. 111p. (In French). (LP-130). Dep. NTIS (U. S. Sales Only).

A new type of high-frequency plasma is described that is particularly well adapted to the experimental demonstration of the parametric instabilities predicted by V.P. Silin, Yu. M. Aliev, and E. Ferlenghi and also Nishikawa, Dubois, and Goldman. Extremely intense high-frequency fields are developed within the plasma. The parameters ν_m, T_e, and E^2/T_e, which play an important role in the instability mechanism are evaluated theoretically. The experimental arrangement and the properties of the plasma over its operating regions are described in detail. It is shown that the behavior of the high-frequency plasma can be clearly interpreted on the basis of plasma resonances. (France)

59064 STABILITY OF RELATIVISTIC PLASMA. Ikuta, Kazunari (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 31: No. 4, 1232-3(Oct 1971).

The $\delta\int dl(1/B)$ criterion of the plasma stability is extended to the relativistic plasma. The relativistic plasma is stable for the interchange instability if $\int(\delta B/B^2)(\Pi_{||} + \Pi_{\perp})dl > 0$, where $\Pi_{||}$ and $\Pi_{\perp}$ are the anisotropic pressure of the relativistic plasma along and perpendicular to the magnetic line of force, respectively. (auth)

59065 ORDINARY-MODE ELECTROMAGNETIC INSTABILITY IN COLLIDING PLASMA STREAMS. Lee, Kai Fong; Armstrong, James C. (Catholic Univ. of America, Washington, D. C.). Phys. Rev., A; 4: No. 5, 2087-94(Nov 1971).

The instability of the electromagnetic linearly polarized mode propagating perpendicular to the magnetic field is studied for a system composed of two colliding plasma streams, in each of which both the electrons and the ions are streaming at the same velocity. Based on the linearized Vlasov–Maxwell equations and allowing for anisotropic temperatures, it is found that in the presence of streaming ions the instability can occur in very low-β plasmas. The higher the values of β, the streaming velocity, and the temperature ratios $T_{||e}/T_{\perp e}$ and $T_{\perp e}/T_{\perp i}$, the more the plasma is susceptible to the electromagnetic instability. The ratio $T_{||i}/T_{||e}$ has negligible influence, except when the streaming velocity is smaller than the ion thermal speed. It is found that for β values of order unity, the streaming ions, while greatly enlarging the range of unstable wave numbers, contribute negligibly to the maximum growth rate, which is typically of the order of the electron cyclotron frequency. A comparison with the growth rates of the electrostatic two-stream instability is made. (auth)

59066 MAGNETOHYDRODYNAMIC INSTABILITIES IN A WEAKLY IONIZED, RADIATING PLASMA. Hougen, Merritt L.; McCune, James E. (Massachusetts Inst. of Tech., Cambridge). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 10, 1947-56 (Oct 1971).

A unified, linear theory is formulated for MHD waves at low magnetic Reynolds number, propagating transverse to the magnetic field in a weakly ionized, radiating plasma. The set of equations obtained from a two-fluid model yields a fifth-order dispersion relation whose roots correspond to four waves: magneto-acoustic (a paired wave), thermal, electrothermal, and "ionization-rate." To bring out the physics of each of these waves, simplifying assumptions are made, and "simple" analytical wave solutions are found. By taking advantage of the wide separation of the roots in the complex plane, "distinct" wave solutions are obtained in which many limitations of the "simple" wave solutions are absent and which are in excellent agreement with the roots of the full dispersion relation, obtained numerically. Both thermal and magneto-acoustic waves are shown to require a two-fluid model for proper description. In particular, the latter mode requires the inclusion of the rate of change of electron enthalpy for wavelengths ≤ 0.1 m at typical MHD generator conditions. The electrothermal wave instability region is much larger than previously thought, whereas the "ionization rate wave" is always stable. (auth)

59067 HIGH-FREQUENCY ELECTROSTATIC PLASMA INSTABILITIES. Freidberg, J. P.; Marder, B. M. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., A; 4: No. 4, 1549-53 (Oct 1971).

A description of the stability properties of a plasma under the influence of an external electric field oscillating near the plasma frequency is presented. (auth)

59068 KINKS AND TEARING MODES IN SIMPLE CONFIGURATIONS. Goedbloed, J. P.; Dagazian, R. Y. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., A; 4: No. 4, 1554-60(Oct 1971).

A plane slab of current-carrying plasma is generally shown to be stable against ideal magnetohydrodynamical modes. It is shown that some of the stability criteria appearing in the literature and contradicting this fact can be brought to bear on the stability of the tearing mode. In this connection, simple stability diagrams are shown for the tearing mode in plane and cylindrically symmetric force-free magnetic fields. (auth)

59069 LOW-FREQUENCY INSTABILITIES IN MAGNETIC PULSES. Krall, Nicholas A.; Liewer, Paulett C. (Univ. of Maryland, College Park). Phys. Rev., A; 4: No. 5, 2094-2103 (Nov 1971).

Electrons drifting relative to ions across a magnetic field are found to drive a set of intermediate-frequency long-wavelength waves ($\omega_{ci} < \omega < \omega_{ce}$) unstable for any temperature ratio T_e/T_i. One instability is caused by the coupling of a drift wave in a nonuniform plasma to either the ion plasma oscillation or a lower hybrid oscillation, depending on density and field strength. Another instability is a form of the two-stream instability, shown here to exist even for drift speeds less than electron thermal speeds. Growth rates are on the order of the ion plasma (or lower hybrid) frequency, depending on the density and field strength. (auth)

59070 ION-CYCLOTRON DRIFT INSTABILITY IN A FINITE-β PLASMA. Mikhailovskii, A. B. (Inst. of Atomic Energy, Moscow). Nucl. Fusion; 11: No. 4, 323-7(Aug 1971).

The possibility of the buildup of ion-cyclotron perturbations in an inhomogeneous plasma having a finite ratio between its pressure and the pressure of a magnetic field is investigated. It is shown that the plasma is more stable with respect to such perturbations at finite pressure than at zero pressure. The stabilization is associated with a smearing of the cyclotron resonance resulting from the velocity dependence of the magnetic drift of the ions; it is also linked with Landau damping in the electrons, the magnetic drift of which coincides with the wave phase velocity. (auth)

59071 DYNAMIC STABILIZATION OF THIN PLASMA FILAMENTS. Nikulin, M. G. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 24-31(Jan-Feb 1970). (In Russian).

The Routh function was found for thin plasma filaments (toroidal

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and linear), testing smooth long-wave perturbations of spiral or constricted type for the case when the external magnetic field is a combination of quadrupole and longitudinal fields. The different variants of dynamic stabilization of the filament are briefly discussed. The combining of dynamic stabilization of linear jets with variable current stabilized by quadrupole and longitudinal fields is studied. (tr-auth)

59072 LOW-FREQUENCY WAVES AND INSTABILITIES IN A MAGNETOPLASMA. Duncan, A. J.; Forrest, J. R. (Stanford Univ., Calif.). pp 389-93 of Gas Discharges. London; Institution of Electrical Engineers (1970).

From International conference on gas discharges; London, England (15 Sep 1970). See CONF-700969.

Instabilities arising in the positive column of a low-pressure gas discharge are discussed, together with means to avoid or suppress them, and a simplified theory of low-frequency wave propagation for a plasma in a uniform magnetic field is presented that predicts observed wave modes and their propagation characteristics. The theory is applicable to frequencies <1 MHz, neutral gas pressures <1 torr, and magnetic fields up to several hundred gauss. A novel feature of the theory is its description of ionization wave propagation in a magnetic field; little experimental data exist for this and, for this reason, propagation experiments were carried out with a He discharge. Comparisons are made between theory and experiment, and agreement was found to be good. Ionization waves are predicted by the theory and shown to be perturbations that, with increasing magnetic field or neutral gas pressure, give rise to instabilities. (UK)

Thermonuclear Processes

59073 (GULF-GA-A-10807) CONTROLLED THERMONUCLEAR RESEARCH PROGRAM. Summary Progress Report, August 1, 1970–July 31, 1971. Ohkawa, Tihiro (Gulf General Atomic Co., San Diego, Calif.). 15 Sep 1971. Contract AT-(04-3)-167 91p Dep. NTIS.

The discussion of the dc multipole is divided into 5 subsections: (1) review of the device and its performance characteristics, (2) classical diffusion at high densities, (3) loss mechanisms at low densities, (4) design criteria and construction of the new toroidal winding, and (5) preliminary experiments with combined poloidal and toroidal magnetic fields. Research on Doublet II is discussed in four subsections: (1) vacuum system, (2) the field shaper, (3) the E-coil system, and (4) the B-coil system. (M.O.W.)

59074 (IPP-1/119) VACUUM MAGNETIC FIELDS OF LINEAR STELLARATORS WITH SHAPED COILS. Lehner, G.; Pohl, F. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jul 1971. 14p. Dep. NTIS (U. S. Sales Only).

The vacuum magnetic fields of linear stellarators with shaped coils are discussed. Two types of expansions are given. The fast one is valid for sufficiently slender coils and the second one for coils with a sufficiently small helical deviation. Some numerical results are described also and compared with the results of the approximations. (auth)

59075 (ORNL-TM-3593) PROPOSAL FOR COMPUTER ASSISTED DATA ACQUISITION FOR ORNL FUSION EXPERIMENTS. Betz, N.; Dory, R. A.; Francis, J. E.; Yonts, O. C. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 29p. Dep. NTIS.

Relatively small, inexpensive computers can provide improved efficiency and reliability for data taking and extend the range of feasible studies. The principal reasons for this are: (1) rapid data sampling with readily varied sampling procedures; (2) archival storage of machine parameters for later analysis; (3) real-time data analysis for determining parameters to be used later (time ~ minutes); (4) preparation of raw experimental data for large-scale analysis at the ORNL computer center (time ~ hours); and (5) possible direct control by computer program of some of the parameters (time ~ milliseconds). (auth)

59076 (UCRL-Trans-10556) INVESTIGATION OF THE LASER INITIATED DISCHARGE SPARK CHANNEL. Zorev, N. N.; Sklizkov, G. V.; Fedotov, S. I.; Shikanov, A. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated for Univ. of California, Lawrence Livermore Lab., from Preprint No. 56. 20p. Dep. NTIS.

Experimental measurements were made of the delay time as a function of laser energy, laser beam focus location, electrode spacing, and pressure. The high-speed schlieren method was used in the experiments. The expansion velocity of the spark channel was measured, and the analysis of gasdynamic processes occurring in the gap for the case of various regimes was considered. The results of an approximate calculation of a discharge scheme are in agreement with experimental data. Minimum risetime was evaluated. It was shown that the use of laser methods to commute discharge gaps makes it possible to form light pulses having duration less than 100 psec. (auth)

59077 EFFECT OF EQUILIBRATING MAGNETIC FIELD ON PLASMA CROSS SECTION. Zakharov, L. E. Sov. Phys. Tech. Phys. (Engl. Transl.); 16: No. 4, 645-6(Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 823-4(Apr 19711)).

A study was made of equilibrium in an axisymmetric plasma annulus of elliptical cross section. A uniform current distribution is assumed. The relationship between the decay index of the equilibrating magnetic field and the ratio of the semiaxis of the cross section was found. It is shown that deviations of the field from uniformity have very little effect on the shape of the cross section. (M.O.W.)

59078 FUSION REACTIONS IN SELF-COLLIDING ORBITS. Maglic, Bogdan C. (Rutgers–The State Univ., New Brunswick, N. J.); Blewett, John P.; Colleraine, Anthony P.; Harrison, W. Craig. Phys. Rev. Lett.; 27: No. 14, 909-12(4 Oct 1971).

A principle for a small nonplasma fusion device is proposed. Energetic ions are injected through the center of a Precetron-type magnetic field. An organized non-Maxwellian mixture ("migma") of particles having a central high-density region results. The collisions are predominantly head-on and Coulomb scattering effects significantly reduced. It is shown that the device can become critical, although, in the examples considered here, only at microwatt levels. (auth)

59079 TORUS DEVICE FOR THERMONUCLEAR FUSION EQUIPMENT: JFT-1. Kazawa, Yoshiaki; Wase, Keizo; Hashimoto, Hiroshi (Hitachi Ltd., Ibaraki, Japan). Hitachi Hyoron; 53: No. 4, 333-9(Apr 1971). (In Japanese)

A torus device "JFT-1" was constructed. The device is composed of internal conductor coils and toroidal coils. Plasma was confined stably with the internal coils, and more stability was obtained with help of the toroidal magnetic field. The internal coils consist of a HC-1 coil (183 KAT), a pair of HC-2 coils (95 KAT) and a pair of auxiliary coils (70 KAT), and excited by a 130 KJ, 3 KV condenser power source with a time interval of 1 min. Investigations of electromagnetic forces due to the coils were carried out. (Japan)

59080 HIGH-CURRENT HOLLOW-CATHODE ION SOURCES. Zeyfang, E. (DFVLR, Stuttgart). pp 251-5 of Gas Discharges. London; Institution of Electrical Engineers (1970).

From International conference on gas discharges; London, England (15 Sep 1970). See CONF-700969.

Development work on ion sources for Hall Ion Thrusters (HIT) is described. In this type of ion accelerator there is no limitation of current density, since the space charge in the accelerating region is neutralized. This is accomplished by using an annular accelerator channel with a magnetic field perpendicular to the electric accelerating field; the magnetic field traps the electrons within the accelerator channel and permits acceleration of the ions within a neutralized plasma. It is necessary for efficient operation of HITs to produce the ions outside the accelerator channel, and for this reason development work is being undertaken on ion sources for HITs operated with Ar and Hg. (UK)

Wave Phenomena

Refer also to abstracts 58996, 59069, 59070, and 59072.

59081 (AEC-tr-7272) CHARACTERISTICS OF COLLISIONLESS DAMPING OF ELECTROMAGNETIC WAVE IN A REGION OF INTENSE INHOMOGENEITY OF A COLD PLASMA. Dolgopolov, V. V.; Omel'chenko, A. Ya. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translation of report KHFTI-69-53. 17p. Dep. NTIS.

The electromagnetic oscillations caused by initial perturbations were studied at the boundary of a semi-infinite plasma with a vacuum with allowance for finiteness of transition region from a homogeneous plasma to the vacuum, and also in an inhomogeneous plane-parallel layer of plasma in the case when the length of a wave propagating along the layer is appreciably greater than the layer's width. It was demonstrated that the surface waves caused by an initial perturbation, in a time interval determined by the width of the region in the inhomogeneous medium, convert fully to Langmuir-type oscillations, occurring along the direction of plasma density gradient and concentrated in the vicinity of the plasma resonance point. This vicinity forms a small part of the region of the plasma's inhomogeneity. If the width of the medium's inhomogeneity region is comparable with the wave length, in general the oscillations having the same frequency in various points of an inhomogeneous medium, do not exist. In a general case (at arbitrary relationship between wave length and typical dimension of inhomogeneity) as a result of the development of initial perturbation in plasma, the Langmuir oscillations will remain (their frequency differs at various points of an inhomogeneous medium); the effective wave vector of these oscillations in the direction of the plasma's density gradient increases without limit through time. (auth)

59082 (CEA-CONF-1803) LINEAR CONVERSION OF WAVES FOR AN OBLIQUE INCIDENCE. Fichet, M.; Fidone, I.; Granata, G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1971]. 2p. (In French). (CONF-710527-3). Dep. NTIS (U. S. Sales Only).

From Physics conference; Evian, France (25 May 1971).

Linear conversion of waves at the upper hybrid resonance for oblique propagation is considered. The conditions for the validity of a fourth-order equation near the resonance are discussed. (France)

59083 (CEA-CONF-1826) DIELECTRIC PROPERTIES OF PLASMA PENETRATED BY THE HELICON WAVE AND ITS INFLUENCE ON MICROINSTABILITIES IN THE CASE OF ANISOTROPIC ION TEMPERATURES. Teichmann, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1971]. 4p. (CONF-710920-10). Dep. NTIS (U. S. Sales Only).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

The influence of the helicon wave upon several kinds of microinstabilities has been discovered recently. The effect observed is due to the particular properties of the plasma hf field system. The changes observed in the plasma dielectric properties when submitted to a strong hf field were studied. Only microinstabilities generated by the anisotropy of the ion temperature were considered. (France)

59084 (CEA-CONF-1827) LOWER-HYBRID WAVE-PLASMA INTERACTION. Pesic, S. S. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1971]. 4p. (CONF-710920-9). Dep. NTIS (U. S. Sales Only).

From tenth international conference on phenomena in ionized gases; Oxford, England (13 Sep 1971).

In order to estimate the role of the boundedness of laboratory plasmas in wave energy transfers, the interaction between obliquely incident electromagnetic waves and a nonuniform plasma column confined in an axial static magnetic field was analyzed. The influence of the particle thermal motion on the wave absorption by the cold plasma was investigated. (France)

59085 STATIONARY SIMPLE WAVES IN A PLASMA AT ANISOTROPIC PRESSURE. Kartalev, M. D. Izv. Akad. Nauk SSSR, Mekh. Zhidk. Gaza; No. 2, 12-19(Mar-Apr 1971). (In Russian).

The character of stationary, simple waves in a plasma at anisotropic pressure is investigated, using the hydrodynamic equation of Chew, Goldberger, and Low. When the average current velocity vectors and the magnetic field intensity are parallel, the system of equations converges to two quasi-linear equations for a velocity component. For an assumed hyperbolic character of this system, a characteristic set of equations is obtained. The character of simple waves flowing around various contours is examined. In a third part of the article the change in current parameters is qualitatively discussed. The fourth part is concerned with the possible transition of the plasma into an unsteady state. (tr-auth)

59086 WEAK NONLINEAR MAGNETO-ACOUSTIC WAVES IN AN INHOMOGENEOUS PLASMA. Kakutani, Tsunehiko (Kyoto Univ.). J. Phys. Soc. Jap.; 31: No. 4, 1246-8(Oct 1971).

Effect of inhomogeneity in plasma density and magnetic field on the propagation of magneto-acoustic waves in a cold collision-free plasma is investigated. It is shown, by using a nonlinear perturbation method, that the basic system of equations governing one-dimensional plane waves with small but finite amplitude can be reduced to a modified form of the Korteweg–de Vries equation, from which one can expect damping, growing, or splitting of the waves. (auth)

59087 EXACT TEST-PARTICLE PROPAGATOR OF THE LENARD-BERNSTEIN EQUATION FOR A MAGNETOPLASMA AND ITS APPLICATION TO THE TRANSVERSE-PLASMA ECHOES. Furutani, Y. (Faculte des Sciences, Orsay, France. Univ., Paris). Phys. Rev., B: 4: No. 4, 1577-83(Oct 1971).

An exact test-particle propagator of the Lenard–Bernstein equation in the presence of an external magnetic field is obtained as a generalization of the well-known bivariate Gaussian distribution given by Chandrasekhar. This propagator is applied to the problem of temporal transverse-plasma echoes. The free-particle model used here can predict a transverse echo when one of the two external signals is transverse and the other longitudinal. When both of two external excitations are transverse, it does not explain a plasma-wave echo, unless velocity increments of particles along the external magnetic field are explicitly given as a function of their transverse energy increments. The reason is that transverse velocity increments can not properly account for the circularly polarized nature of exciting signals. (auth)

59088 WAVE ABSORPTION IN A MAGNETOACTIVE PLASMA WITH SMALL TRANSVERSE DIMENSIONS. Fedorov, V. I. (Leningrad Polytechnic Inst.). Sov. Phys. Tech. Phys. (Engl. Transl.); 16: No. 4, 533-7(Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 680-6(Apr 1971).

Solutions are obtained for the wave equation for a cylindrical column of a cold, magnetoactive plasma of small radius for the approximation that the electron density in the plasma is a parabolic function of the radius. This solution is used to compute damping constants for circular and rectangular waveguides containing cylindrical plasma tubes. (auth)

59089 EDGE EFFECTS IN EXCITATION OF MAGNETO-ACOUSTIC WAVES IN PLASMA. Balakhanov, V. Ya. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 517-23(Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 660-8(Apr 1971).

The excitation of magnetoacoustic waves in an infinite cylindrical plasma column is discussed. It is found that the field in the plasma is composed of the sum of the direct and oblique waves and that the oblique wave is a standing wave fixed with respect to the edge of the coil. The total field in the vicinity of the edge of the coil depends on the excitation frequency and is a complicated function of the plasma parameters. Experimental observations of the excitations of magnetoacoustic waves in the plasma can be used to determine the dissipation of the field in the plasma and the components of the dielectric tensor. The results are presented in the form of an analytic solution in a rapidly converging series. (auth)

59090 NONSTATIONARY WEAKLY NONLINEAR WAVES THAT PROPAGATE AT AN ANGLE TO THE MAGNETIC FIELD IN A MULTICOMPONENT COLD PLASMA. Pataraya, A. D. (Inst. of Physics, Tbilisi, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 515-6(Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 657-9(Apr 1971).

Nonstationary, weakly nonlinear waves that propagate at an angle to the magnetic field in a multicomponent quasineutral fully-ionized cold plasma were investigated. The perturbed plasma variables satisfy an equation similar to one found for weakly modulated waves in nonlinear optics. (auth)

59091 MICROWAVE ABSORPTION BY A PLASMA AT THE UPPER HYBRID FREQUENCY. Anisimov, A. I.; Vinogradov, N. I.; Golant, V. E.; Pakhomov, L. P. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 546-9(Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 696-700(Apr 1971).

It was shown earlier that a collisionless plasma has a linear absorption mechanism due to transformation of electromagnetic waves to plasma waves. The region in which microwave absorption occurs when transformation is possible was investigated. The experiments were performed in a toroidal magnetic field, in which the plasma parameters are uniform along the field under appropriate conditions. (M.O.W.)

59092 SURFACE WAVES IN A MAGNETIZED PLASMA. Kotsarenko, N. Ya.; Sinkevich, E. L.; Fedorchenko, A. M. (Kiev State Univ.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 640-1(Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 818-20(Apr 1971).

The dispersion relation is obtained for surface waves propagating along a planar vacuum–plasma boundary at an arbitrary angle θ to a magnetic field parallel to the boundary. It is shown that (except for $\theta = \pi/2$) the waves are generalized surface waves, i.e., the attenuation within the plasma is of an oscillatory nature. (auth)

59093 LOW-FREQUENCY WAVES IN DENSE PLASMA CONTAINING TWO ION SPECIES. Chechkin, V. V. Sov. Phys. Tech. Phys. (Engl. Transl.); 16: No. 4, 637-9(Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 815-17(Apr 1971).

The interaction of alfven and magnetoacoustic waves with a two-component plasma is discussed. In particular, the reflection and transmission properties are examined. (M.O.W.)

59094 PROPAGATION OF LARGE-AMPLITUDE TM WAVES IN A MAGNETOACTIVE PLASMA. Demchenko, V. V.; Dolgopolov, V. V. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 661-3 (Oct 1971).

XUM

Translated from Zh. Tekh. Fiz.; 41: No. 4, 839-40(Apr 1971).

Propagation of electric electromagnetic modes along a magnetoactive plasma is examined in the case in which there is a strong nonvarying magnetic field (with gyrofrequencies much greater than the corresponding plasma frequencies and wave frequency) transverse to the layer and the pressure of the electromagnetic field of the mode is much greater than the gas-kinetic pressure of the plasma. A dispersion equation containing no amplitude or temperature terms is derived in the large-amplitude approximation. An equation is found for the plasma density of a layer of varying thickness. The plasma density distribution is also independent of the wave amplitude and plasma temperature. (auth)

59095 ION WAVES EXCITED BY A GRID IN A COLLISIONLESS PLASMA. Gresillon, D. (Ecole Polytechnique, Paris). J. Phys. (Paris); 32: No. 4, 269-82(Apr 1971). (In French).

A theoretical and experimental study of ion dynamics in longitudinal ion waves in single-ended collisionless Q machine plasma is presented. The theory gives special attention to the properties of the first Landau pole and to the grid excitation mechanism. The latter allows the calculation of the excitation coefficients of the normal modes and the development of the first-order ion distribution function f_1. The experiments show dispersion of ion waves, and the collisionless damping is measured. These aspects are discussed in connection with the simultaneous measurement of the stationary ion distribution f_0. Finally, attention is directed towards the measurement of f_1, and preliminary results are presented. (France)

59096 RESONANT INTERACTION OF CHARGED PARTICLES WITH A CYCLOTRON WAVE. Kovtoune, R. I. (CEN, Fontenay-aux-Roses, France). J. Phys. (Paris); 32: No. 4, 283-93(Apr 1971). (In French).

The resonant interaction of charged particles with a cyclotron wave is discussed in a case where the wave propagates in a boundless plasma along a strong uniform magnetic field. Particle motion is studied with the help of the asymptotic method where the amplitude of a relative perturbation of the uniform magnetic field by the wave is used as a small parameter. Explicit expressions are found for the time dependence of particle longitudinal and transversal velocities, the latter being always finite contrary to predictions of the linear theory where longitudinal velocity variations are neglected. It is shown that the solutions obtained are reduced to those given by the linear theory, when the difference between cyclotron and Doppler-shifted wave frequency becomes large. (France)

59097 INFLUENCE OF SPATIAL DISPERSION ON THE COEFFICIENT OF SPONTANEOUS EMISSION OF CYCLOTRON RADIATION IN A NONEQUILIBRIUM PLASMA. Jahn, Herbert (Zentralinstitut fuer Solar-Terrestrische Physik, Berlin). Astrophys. Space Sci.; 12: No. 1, 34-9(Jul 1971).

The coefficient of spontaneous emission of cyclotron radiation propagating in the direction of an external magnetic field in nonequilibrium plasma was calculated, including the effect of spatial dispersion on the emission process. The resulting part of the emission coefficient may become important in the vicinity of the cyclotron frequency. (auth)

59098 INTERACTION BETWEEN ION–ACOUSTIC WAVES AND IONIZATION WAVES. Franklin, R. N. (Oxford Univ.). pp 563-73 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

A brief theoretical treatment of ion waves and ionization waves in discharges is given. Some experimental data showing these waves in various gas discharges are presented. (M.O.W.)

59099 NONLINEAR INTERACTION OF ELECTRON PLASMA WAVES. Franklin, R. N. (Oxford Univ.). pp 574-85 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

The following topics are discussed in general terms: (1) large-amplitude waves, (2) resonant interactions, (3) parametric generation, (4) nonlinear Landau damping and (5) plasma wave echoes. (M.O.W.)

59100 GUIDED ELECTRON PLASMA WAVES. Anicin, B. A. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 586-613 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

A review is given of research carried out at the Boris Kidric Institute of Nuclear Sciences in Belgrade on slow electromagnetic waves on plasma columns. The following areas are described: (1) dispersion relations of surface waves on inhomogeneous plasma, (2) measurements of attenuation, (3) effects of phase modulation on attenuation measurements, (4) radiation fields associated with surface waves, and (5) pulse propagation on positive columns in the form of surface waves. (M.O.W.)

59101 NEW TECHNIQUE FOR THE OPTICAL GENERATION OF ELECTRON PLASMA WAVES. Burgess, D. D.; Richards, A. G.; Mahon, R. (Imperial Coll. of Science and Tech., London). J. Phys., B (London); 4: No. 9, L76-80(Sep 1971).

The coupling between transverse and longitudinal fields caused by bound electrons in a plasma provides a practical means for the optical generation of electron plasma waves (plasmons). The process has a threshold above which it becomes self-stimulated. (auth) (UK)

59102 TRANSVERSE WAVES AND INSTABILITIES IN A UNIFORM PLASMA FOR PROPAGATION ALONG THE MAGNETIC FIELD. Sestero, A.; Curatolo, M. (Laboratori Gas Ionizzati, Frascati, Italy). Nuovo Cim.; 5B: No. 2, 165-80 (11 Oct 1971).

A compact survey is presented of the linear theory of transverse waves and instabilities in a uniform plasma, for propagation along the magnetic field. Both the multifluid and the kinetic description are considered, the latter according to Landau's approach. The stability properties of the equilibrium are discussed in terms of marginal mode analysis (rather than in terms of Nyquist diagrams), leading to certain stability criteria. Damping and growth rates are explicitly evaluated in the long-wavelength limit for a number of waves and instabilities (e.g., the electron whistler mode, the electromagnetic modes, the transverse temperature anisotropy, and loss-cone instabilities). (auth)

59103 DAMPING OF DRIFT WAVES. Mazimov, R. K. Zh. Prikl. Mekh. Tekh. Fiz.; No. 1, 53-5(Jan-Feb 1970). (In Russian).

The absorption of monochromatic waves propagating in inhomogeneous plasma at angles to the magnetic field is studied. Nonlinear equations of resonance particles are resolved in the drift approximation. The nonlinear decrement of damping is calculated. (tr-auth)

59104 INFLUENCE OF LONGITUDINAL DENSITY GRADIENT ON THE TRANSFORMATION AND EMISSION OF TRANSVERSE WAVES FROM A BEAM-PLASMA DISCHARGE. Berezin, A. K.; Berezina, G. P.; Erokhin, N. S.; Moiseev, S. S.; Fainberg, Ya. B. JETP Lett. (USSR) (Engl. Transl.); 14: No. 3, 97-9(5 Aug 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 3, 149-52(5 Aug 1971).

An experimental and theoretical investigation was made of the efficiency of the processes of transformation of longitudinal waves into transverse ones as a function of the direction of the longitudinal density gradient. It is shown that the sign of the density gradient strongly influences the radiation intensity of the transverse waves. (M.O.W.)

59105 COUPLED EQUATIONS IN THE THEORY OF LINEAR WAVE CONVERSION. Fidone, I. (CEN, Fontenay-aux-Roses, France). Nuovo Cim.; 5B: No. 2, 219-36(11 Oct 1971).

The problem of linear conversion of electromagnetic waves into short-wavelength plasma modes is formulated in the framework of the theory of coupled equations for characteristic waves. The method of Clemmow and Heading is generalized to warm plasma, obtaining second-order coupled equations with the coupling reduced as far as possible. The equations have a relatively simple form for three cases, namely: (i) $k_x = 0$ and l, m, n arbitrary, (ii) $k_x \neq 0$, $m = n = 0$ and $l = 1$, and (iii) $k_x \neq 0$, $m = l = 0$ and $n = 1$. Here l, m, n are the direction cosines of the external magnetic field, k_x is the constant component of the wave vector and the plasma is weakly inhomogeneous along the z direction. The equations show that near the region where wave conversion takes place only one of the two characteristic waves of the cold plasma is of interest. A detailed analysis of the Foersterling coupling parameter for case (ii) is carried out, and the conditions for further simplifications are found. (auth)

Shielding

Refer also to abstracts 58025, 58470, 58471, 58547, 58689, 58851, 59041, 59657, 59674, 59679, 59680, 59682–59684, and 60055.

59106 BREMSSTRAHLUNG YIELD AS FUNCTION OF TARGET THICKNESS AND ATOMIC NUMBER IN THE ELECTRON ENERGY RANGE 12 TO 22 MeV. Kovalev, V. P.; Kharin, V. P.; Gordeev, V. V.; Borisov, M. S. At. Energ. (USSR); 31: No. 3, 289-92(Sep 1971). (In Russian).

Using a direct electron beam from a linear accelerator, the yield of bremsstrahlung was determined as a function of target thickness for Al, Ti, Cu, Mo, Ta, and W discs 40 mm in diameter. The detector was placed 1 m from the target and on the beam axis; it consisted of a thimble detector with an adapter and threshold indicators [$^{63}Cu(\gamma,n)^{62}Cu$, etc.] for sensing bremsstrahlung. Relative yields from different targets were measured with various detectors for electron-beam energies of 12.5, 16, and 22 MeV. The data are given in the form of tables and graphs. (K.S.W.)

59107 MEASUREMENT OF PHOTON INDUCED HIGH ENERGY SECONDARY ELECTRON EMISSION. Spencer, Russell Boone. Los Angeles; Univ. of California (1970). 246p. University Microfilms Order No. 71-16,365.

Thesis.

Experiments were performed to measure the energy and angular distributions of secondary electrons emanating from several target materials. Eight materials (Al, Ti, Cu, Mo, Cd, Ta, Pb and U) ranging in thickness from 0.003″ to 0.5″ were used. The photon source used for the experiment was a 3-Ci ^{60}Co source with photopeaks at 1.17 and 1.33 MeV. Pulse-height spectra (256 energy groups) of the emitted electrons were measured at 0, 10, 15, 20, 25, 30, 40, 50, and 60° to the beam forward direction for the gamma beam normal to the target. The pertinent theoretical aspects of electron generation by photons and electron emission from material are presented. Based on a general theoretical model of secondary electron generation in matter and emission from materials, two simplified models are investigated for their utility in predicting high-energy secondary electron emission. The results of numerical calculations based on the two models are compared with the results of the experiment. In addition, the results of a survey of previous experimental research concerning photon-induced secondary electron emission are summarized and compared with the results of the UCLA—NEL experiment. A computer program was developed to analyze and reduce the data collected by the pulse height analyzer. The program computes the differential and integral electron energy and angular distributions from the raw experimental data and plots them. The reduced experimental results are compared with: (1) numerical results calculated by employing a simplified secondary electron emission model, (2) numerical results obtained by using Monte Carlo techniques for predicting the photon and electron transport, and (3) experimental results obtained from other researchers. (TSS) (Diss. Abstr. Int., B)

59108 SEMIEMPIRICAL FORMULAS FOR GAMMA-RAY DOSE RATES THROUGH TWO-LAYER SLAB SHIELDS. Sharp, David A.; Carnesale, A. (North Carolina State Univ., Raleigh). Nucl. Technol.; 12: No. 4, 375-80(Dec 1971).

A series of dose-rate calculations in two-layered slab shields was performed, using a Monte Carlo technique, at combinations of source energy and slab thickness selected with the aid of a composite experiment design. Least-squares fits to the dose-buildup factors obtained from these calculations yield equations in which the dose buildup factor is represented as a quadratic function of the source energy and the thicknesses of the materials composing the shield. The accuracy of these equations was established by comparisons with existing data. (auth)

59109 TRANSPORT THEORY. Proceedings of the Symposium on Interdisciplinary Applications of Transport Theory, Oxford, England, September 1–4, 1970. Atlas Symposium No. 3. J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 511-1030 (Jun 1971). (CONF-700970).

Thirty-eight papers were presented at the Symposium. Separate abstracts were prepared for eighteen considered to be within the scope of NSA. (UK)

For abstracts of individual papers see: 58467—58474, 58543, 59041, 59110—59114, and 59682—59684.

59110 BELLMAN'S NEW APPROACH TO THE NUMERICAL SOLUTION OF FREDHOLM INTEGRAL EQUATIONS WITH POSITIVE KERNELS. Gruschinske, Juergen; Ueno, Sueo (Kyoto Univ.). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 641-6(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

Using Bellman's new technique, it is shown how to solve numerically the integral equation of the source function of the radiation field in a homogeneous, isotropically scattering spherical medium or hollow spherical shell medium with no flux of radiation incident on the outer surface and with an isotropically emitting central point source. By Bellman's method, the integral equation for the source function is converted into a system of linear simultaneous, first order ordinary differential equations of the initial value type. (auth) (UK)

59111 MULTIGROUP TRANSPORT EQUATION WITH A SEPARABLE KERNEL. Silvennoinen, P.; Zweifel, P. F. (Virginia Polytechnic Inst., Blacksburg). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 869-77(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

An N-group, one-dimensional, time-independent transport equation with a separable scattering kernel is considered. Full- and partial-range completeness relations are proved, using the methods described in the book of Vekua. The procedures used are simple generalizations of a similar problem with two energy groups treated by the same authors elsewhere. (auth) (UK)

59112 MILNE'S PROBLEM FOR TWO-DIMENSIONAL TRANSPORT IN A QUARTER SPACE. Lam, S. K.; Leonard, A. (Stanford Univ., Calif.). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 893-904(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

Double Fourier transformation of the one-speed transport equation is used to determine a family of solutions to the homogeneous (Milne's) problem for the quarter space. All contributions to the density asymptotically away from the corner are determined explicitly by considering two appropriate half-space problems and by extensive use of contour integration in two complex variables. An iterative scheme previously derived may be used to determine the correction near the corner. (auth) (UK)

59113 PROPERTIES OF NEW NUMERICAL APPROXIMATIONS TO THE TRANSPORT EQUATION. Lathrop, K. D.; Carlson, B. G. (Los Alamos Scientific Lab., N. Mex.). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 921-48 (Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

Two new numerical methods are formulated for the solution of the Boltzmann transport equation. Both methods are designed to reduce distortion of angular flux distributions produced by conventional S_N or discrete-ordinates formulations. For the first method, in which the distribution function is represented by a set of discrete discontinuous straight lines, a general formulation is given; and, as an example, finite-difference equations are derived for two-dimensional rectangular geometry. The relationship to connected straight line and step function representations is shown, and an estimate of the relative truncation error of these schemes is given, showing that the new scheme has the potential of suppressing spatial oscillations without loss of second-order accuracy. By Fourier analysis of the line-source problem, it is shown that the lowest order of the new approximation (CS_2) compares favorably with the usual S_4 discrete-ordinates approximation in the suppression of ray effects. This result is confirmed by numerical comparisons. The second new method involves the conversion of two (or higher) dimensional discrete-ordinates equations to angular moments equations to eliminate the directional streaming properties of discrete-ordinates equations. Three approaches are examined for these conversions. In the first, the general formula is given for the artificial source needed to truncate the spherical harmonics moments equations derived from discrete-ordinates equations in (x,y) rectangular geometry. While it is shown that the moments in these equations may not be the coefficients in the polynomial expansion of the discrete-ordinates flux, numerical results from this conversion show greatly smoothed scalar fluxes. A second conversion formula, in which an artificial source is introduced to make the highest-order spherical-harmonics moments vanish, also produces smooth fluxes in numerical examples but requires more iteration than the first method. In the third approach, artificial source corrections to convert discrete-ordinates equations to angular-moments equations with exact equivalence are given. (auth) (UK)

59114 NUMERICAL SOLUTION OF THE UNSTEADY RADIATIVE-TRANSFER EQUATION. Hankin, B. C.; Hill, J. G.; Warham, A. G. P. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 949-62(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

XUM

In problems involving the transport of radiation through matter, it is necessary to solve the radiative transfer equation numerically. The scope for analytic solutions is restricted because of the complexity of the radiation–material interaction problem; this is particularly severe if the material is compressible. A study is made of various difference schemes within the framework of the discrete S_N method with a view to obtaining a well-behaved solution. In addition to the usual requirements of consistency, stability, and accuracy, there are further desirable features. Firstly, it is preferable to keep in the difference scheme, the photon conservation property as expressed by the basic transport equation. Secondly, the solution should be non-negative, not only because such values are unphysical, but also because of their effect on the radiation–material coupling. Such a coupling is usually nonlinear, and negative solutions can lead to instabilities in the numerical solution. Finally, it is preferable that the method should lead to simple calculations. Results are given for an example involving the radiative heating of a semi-infinite slab. It is shown that the diffusion limit imposes a particularly severe test, and the method used by Lathrop in the computer code DTF-IV is favored. A second example demonstrates a disturbing oscillatory behavior arising from Diamond differencing which is basic to the DTF-IV method. A modification to this method designed to overcome this problem is examined. (auth) (UK)

59115 EFFECT OF SECONDARY EMISSION ON THE POTENTIAL OF A METALLIC BODY IN ELECTRONIC RADIATION FIELDS ON THE EARTH. Ryabova, T. Ya.; Trukhanov, K. A. Izv. Akad. Nauk SSSR, Ser. Fiz.; 35: No. 5, 1075-9(May 1971). (In Russian).

Much experimental and calculated data is available on the equilibrium potential relative to unscreened cosmic instrumentation in magnetospheric plasma. Screening the equipment with thin outer screens (~0.01 g/cm^2) leads to a change of conditions of the formation of the equilibrium potential because of the redistribution role of leakage currents in the total balance of charge. The possibility of establishing a large negative charge on the screened cosmic apparatus was examined, which might be used for radiation protection of the system, materials, and crew from intense electron currents. Screening leads to absorption of uv radiation of the sun and of ions of the magnetospheric plasma, causing a charge loss from the surface of unscreened apparatus. A theoretical analysis of these conditions is presented, in which a metallic body represents the apparatus in question. The final equation permits calculation of the integral dose of bremsstrahlung from electrons permissible in a flight. (K.S.W.)

59116 COMPARISON OF RANGE-ENERGY CALCULATIONS OF HEAVY IONS IN SILICON USING THE INVERSE SQUARE LAW AND THOMAS–FERMI POTENTIALS. Littlejohn, M. A.; Holloman, S. B. (North Carolina State Univ., Raleigh). Radiat. Eff.; 10: No. 1-2, 133-4(Jul 1971).

The projected range and projected range straggling of heavy ions in silicon are calculated using an inverse square law potential. These results are compared with similar computations using the Thomas–Fermi potential. It is shown that there is reasonable agreement between these two models for ion energies between 20 and 400 keV. (auth)

59117 SEMI-EMPIRICAL REPRESENTATIONS OF NEUTRON AND GAMMA RAY DOSE RATES IN TWO-LAYERED SLAB SHIELDS. Sharp, David Alexander. Raleigh, N. C.; North Carolina State Univ. (1970). 152p. University Microfilms Order No. 71-20,147.
Thesis.

Equations are developed that specify the dose rate due to the attenuation of neutrons and gamma rays through shields composed of two materials. These equations are generated from least-squares fits to dose rate data that are calculated using a Monte Carlo computer code. The calculations are performed at a series of independent-variable combinations that are selected using a composite experiment design. For gamma rays, the dose buildup factor of the radiation emerging from the shield is expressed as a quadratic function of the energy of the incident radiation and the optical thickness of the shield materials at this energy. The equations are developed for shield material combinations of lead/water, water/lead, iron/water, and water/iron. They are applicable for incident energies from 0.5 to 10 MeV and for individual slab thicknesses from 0.5 to 5.0 mean free paths. The dose rates yielded by these equations are compared extensively with data from the literature. The mean difference that results from these comparisons is within 10% for each equation. The total dose rate resulting from the attenuation of uranium-235 fission neutrons in a composite shield of iron and water is expressed as a quadratic function of the thicknesses of these materials. Collided dose rates are computed using the Monte Carlo code, while uncollided dose rates are determined from a numerical integration procedure. The resulting equation is applicable for iron thicknesses up to 4 inches, followed by up to 12 inches of water. The total dose, as predicted by this equation, decreases approximately exponentially with increasing shield thickness. A calculation of the penetration of secondary gamma radiation produced by neutron inelastic scattering, performed at one thickness combination, indicates that the dose resulting from this effect amounts to less than 1% of the total. (Diss. Abstr. Int., B)

59118 COMPTON AND RAYLEIGH SCATTERING OF X RAYS BY HETEROGENEOUS MATERIALS. Bramwell, S. E.; Carr-Brion, K. G.; Stuart, J. P. (Warren Spring Lab., Stevenage, Eng.). Nature (London) Phys. Sci.; 233: No. 36, 8-9(6 Sep 1971).

During studies of Compton and Rayleigh scattering from suspensions and slurries it was observed that the x-ray intensities showed a marked dependence on the size of the grains of the more strongly absorbing component, and a detailed study of these effects is described, in view of the potential industrial application of the technique to the determination of particle size. Uranium L x rays, obtained from a sealed 30-mCi ^{238}Pu source, were employed for the studies. (UK)

59119 γ-RAY INDUCED SCINTILLATION. Zhemerev, A. V.; Medvedev, Yu. A. This paper was summarized in At. Energ. (USSR); 29: No. 4, 287(Oct 1970) as paper No. 435/5837. (In Russian).

The characteristics of scintillation in air induced by a nonstationary, isotropic, point γ radiator is investigated taking into account effects of time retardation and self-absorption of light in the volume of the radiator due to the knocking-off of electrons from negative ions of oxygen. (M.H.R.)

59120 INVESTIGATION OF BUILDUP REGION FOR γ-RADIATION FROM LOW-LEVEL SOURCES. Stavitskii, R. V.; Yarkovoi, E. A.; Kheteev, M. V. This paper was summarized in At. Energ. (USSR); 29: No. 5, 366(Nov 1970) as paper No. 442/5725. (In Russian).

Experimental investigation of buildup curves revealed the absence of buildup regions when radiation from low-level sources (specific activity from 4.5 to 450 μCi/g) is recorded. The apparent reason is contamination of the primary beam by electrons or photons of energy below 400 keV. It was found that contamination of the primary beam by photons of energy below 400 keV takes place through scattering of the primary radiation within the source itself. Experimental investigations relying on photographic and scintillation techniques were carried out in order to arrive at a tentative estimate of the amount of radiation scattered by a γ source. The photographic method was applied to a study of the effect of radiation scattered by thin (2-mm-thick) aluminum, iron, and lead radiators. Because of the radiation scattered by the source and by the radiator, the film ended up more fogged than anticipated. The amount of γ radiation scattered by the source itself was estimated by analyzing the change in the spectrum of the collimated radiation measured by a scintillation detector placed after filtration of the radiation by a thin filter. A special procedure developed for processing the spectrograms made it possible to obtain the relative spectral distributions of the scattered radiation in the sources. (auth)

59121 FOURIER TRANSFORM METHODS IN LINEAR TRANSPORT THEORY. Case, K. M. (Rockefeller Univ., New York); Hazeltine, R. D. J. Math. Phys. (N. Y.); 12: No. 9, 1970-80 (Sep 1971).

A three-dimensional Fourier transform method presented previously is generalized to solve various forms of the linearized transport equation in planar geometry. Infinite-space problems are in general easily treated by the procedures. Half-space problems may also be solved analytically in, at least, the following cases: (i) separable scattering kernel (arbitrary particle speed); (ii) one-speed, anistropic scattering with rotation-invariant kernel; (iii) one-dimensional energy-dependent kernel of Kac; (iv) multigroup transport with down scattering only. The general importance of recursion relations to problems with nonseparable kernels is emphasized. A comparison is made between these methods and the two-dimensional singular eigenfunction approach, and a criterion is presented for the analytic solubility of any problem of the general form considered. (auth)

59122 PRECISE MEASUREMENTS OF W, THE MEAN ENERGY EXPENDED PER ION PAIR FORMED IN ALKANE VAPORS AND IN ARGON. Stoneham, Thomas Ash. Houston, Tex.; Univ. of Houston (1970). 97p. University Microfilms Order No. 71-19,102.
Thesis.

Ionization currents were measured for the complete stopping of ^{63}Ni beta rays in nitrogen, in argon, in the normal alkanes through heptane and in the branched-chain alkanes through hexane. Values of W, the mean energy expended per ion pair formed, were determined from the ratio of ion current in nitrogen to that in the sample, relative to the W for nitrogen, 34.6 eV [G. N. Whyte, Radiation Res., 18: 265(1963)]. W(beta) values for alkanes were measured with a precision of ca 0.1% and that of argon within 0.2%. No variation of W was experienced as pressures were increased by a factor of two, up to 2700 torr. There is also no temperature dependency in argon, methane, ethane, and propane in the 25° to 200°C range. Energy-balance considerations reveal that at least half of the energy absorbed in the complete stopping of electrons in vapors of normal alkanes C_1 to C_5 is expended in ionization, while about one third goes into excitation and the rest remains in subexcitation electrons. W(beta) correlates well with molecular structure in the normal and branched alkanes. Ionization potentials (I_0) as well as W's may be predicted empirically by extrapolating values from tables of W, I_0, and W/I_0. (Diss. Abstr. Int., B)

59123 IONIZATION MEASUREMENTS IN MERCURY VAPOR WITH BETA PARTICLES AND THE MEAN ENERGY TO FORM AN ION PAIR. **Jesse, William P. (St. Procopius Coll., Lisle, Ill.). J. Chem. Phys.; 55: No. 7, 3603-4(1 Oct 1971).**

Ionization currents formed in Hg vapor by bombardment by ^{63}Ni β particles were measured successively as the pressure of the gas was raised. The mean energy for formation of an ion pair, W, was calculated by comparing these results with corresponding measurements for argon for which the W value is precisely known. The value obtained for W_{Hg} was 23.6 ± 0.2 eV/ion pair. The ratio of W to the lowest ionization potential of the gas was found to be 2.27. (A.G.W.)

59124 INELASTIC ENERGY LOSSES OF SLOW IONS IN SOLIDS. Yarkulov, U. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 69-72 (1970). (In Russian).

A screened Coulomb potential was used in deriving formulas for energy losses of slow ions in solids. The velocity of the electrons of the slowing-down medium was taken into account. The formulas were used to calculate the electronic stopping powers of Au, Ag, Al, and Li for protons at energies of 20 to 1000 keV. It is concluded that energy losses of protons depend nonmonotonically on the atomic number of the stopping material and are related to atomic shell structure. (A.G.W.)

Solid-State Physics

Refer also to abstracts 57904 and 58184.

Radiation Effects

Refer also to abstracts 57903, 58412, and 58739.

59125 (JUL-729-FF) DETERMINATION OF THE ANISOTROPY OF THE THRESHOLD ENERGY FOR THE PRODUCTION OF FRENKEL DEFECTS IN TANTALUM. **Jung, Peter (Kernforschungsanlage, Juelich (West Germany). Institut Festkoerperforschung). Feb 1971. 71p. (In German). Dep. NTIS (U. S. Sales Only).**

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

The effective cross section for the production of Frenkel pairs was determined on 15-μ Ta crystal foils with (110) orientation. The cross section was determined in the energy range from 1.0 to 3.2 MeV in dependence on the orientation of the foil to the electron beam over a wide range in the orientation triangle. In contrast to the previously studied fcc metals Cu and Au, a strong directional dependence of the damage rate was found in the energy range over 1.3 MeV. The measurement values were corrected with reference to the beam propagation through the finite sample. An attempt was made to adapt various threshold-energy profiles to these corrected values. A satisfactory agreement was obtained only with those profiles in which the mean threshold energy in the regions of 20° around the (111) direction increases 36 ± 2 eV, in the regions of 18° around the (100) direction 53 ± 3 eV, and in the region between the principal direction to over 130 eV. The existence of such windows about the principal directions strongly indicate that stable Frenkel pairs were produced by displacement collisions; i.e., in general, the primary bombarded atom does not form the interstitial atom. Whereas the occurrence of these threshold-energy windows around the (111) and (100) direction agrees with the results from the Erginsoy computer experiments for bcc iron, the relative sizes of the thresholds in the principal directions are in opposition to the results of Erginsoy and to the estimation of H. H. Andersen et al. for Ta. A value of 32 ± 2 eV was obtained as the lowest threshold and the resistance increase per at. % Frenkel pairs was 17 ± 3 μΩcm. (tr-auth)

59126 EFFECTS OF POINT DEFECTS ON ELASTIC PRECURSOR DECAY IN LITHIUM FLUORIDE. **Asay, James Russell. Pullman, Wash.; Washington State Univ. (1971). 184p. University Microfilms Order No. 71-18,559.**

Thesis.

Data are reported for shock wave propagation along a ⟨100⟩ crystallographic direction in single-crystal LiF. Shock waves were obtained by impacting the specimens with an aluminum (6061-T6) projectile at a velocity of approximately 0.34 mm/μsec. The average initial stress produced at the impact surface was about 28.6 kbars. Quartz gauges were used to measure attenuation of the elastic precursor for propagation distances ranging from about 0.25 mm to 15.5 mm. The maximum precursor amplitude observed in the study was approximately 21 kbars for a specimen 1 mm in thickness. A minimum value of about 2 kbars was observed for large propagation distances. The present study shows that elastic precursor decay in LiF is critically dependent upon the presence of point defects. These were in the form of cation impurities in most of the specimens and were obtained through gamma radiation in others. For the observed range in concentration, yield stresses measured at low strain rates varied monotonically with defect concentration from about 0.02 kbar for pure crystals to 1 kbar for the hardest material studied. Dynamic behavior was also strongly dependent on defect concentration. It was found that the corresponding precursor curves showed an initial rapid decay to an apparent equilibrium value of about 2 kbars for very soft crystals. The initial decay rate for hard crystals was also rapid, although the equilibrium stress was higher. However, a minimum in the decay rate was observed for materials which had an intermediate concentration of point defects. Dynamic data are compared with those obtained at low strain rate to show that dislocation processes are different for the two ranges of strain rate employed. Present data suggest that dislocation multiplication controls precursor decay in LiF. The study shows that multiplication behind the wavefront can account for at least half of the observed attenuation in materials which relax slowly. For materials which show a rapid decay, this effect is estimated to be approximately 10 to 30% of the total decay rate. A calculation is also presented which shows that multiplication in the wavefront can contribute significantly to the decay. (Diss. Abstr. Int., B)

59127 COMPARATIVE CHARACTERISTICS OF SUBTHRESHOLD RADIATION EFFECTS IN n- AND p-TYPE SILICON. **Zaikovskaya, M. A. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 70(1971). (In Russian).**

The magnitude of the radiation-induced change in the specific resistance in n- and p-type silicon was measured as a function of the integrated flux of electrons of energies of from 10 to 100 keV. In samples of the n-type, the "sub-threshold" radiation effect was inversely proportional to the free electron concentration. In the p-type, it was directly proportional to the concentration of free holes. (K.S.W.)

59128 EFFECTS OF HEAT TREATMENT AND γ IRRADIATION ON THE PHOTODEFORMATION EFFECT IN GERMANIUM. Khiznichenko, L. P.; Yusupova, D. Yu. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 74-5(1971). (In Russian).

Changes in the photodeformation effect was studied in germanium that had been given thermal and radiation treatments. Two types of monocrystals were used: n-Ge with a specific resistance of 26 ohm · cm and a density of dislocations of 10^4/cm, and a dislocation-free p-type of material with $\rho = 10$ ohm · cm. The radiation source was ^{60}Co yielding 150 R/sec; the thermal treatment consisted of maintenance at 500°C in a nitrogen atmosphere for 20 min, followed by chilling in liquid nitrogen. Chilling the samples produced a change in the photodeformation effect only in the dislocated samples. The photodeformation effect was suppressed in both types of Ge samples by exposure to γ radiation. (K.S.W.)

59129 ABNORMAL STOPPING POWER OF PROTON AND ION CHANNELING. **Ohtsuki, Yoshi-Hiko; Mizuno, Mitsuhiko; Kitagawa, Mitsuo (Waseda Univ., Tokyo). J. Phys. Soc. Jap.; 31: No. 4, 1109-12(Oct 1971).**

A method to calculate the abnormal stopping power of the planar channeled particle in crystal is proposed. Making use of the formula and Bohr's classical model, the abnormal stopping power is calculated as a function of the distance from the channeling wall for electronic and nuclear excitations. (auth)

59130 PROTON DECHANNELING IN Ge PROBES: THE CRYSTAL SCATTERING. **Campisano, S. U.; Grasso, F.;**

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Rimini, E. (Istituto Nazionale di Fisica Nucleare, Catania, Italy. Univ., Catania, Italy). Radiat. Eff.; 9: No. 3-4, 153-64(Jun 1971).

Experimental data on proton dechanneling in Ge are reported; the general features of these results are similar to those reported for Si, although some quantitative differences appear according to the crystal nature. The available experimental data enable a detailed discussion of the approximations involved in dechanneling theory and in calculations. Some emphasis is given to the influence of the potential used to describe the ion–target interaction; significant differences appear on going from the Thomas–Fermi (Moliere) to Lindhard's standard potential. Remarks are also made on the description of the moving-ion interaction with the core and valence electrons as it concerns multiple scattering. The importance of the ion-beam diffusion because of multiple electronic and nuclear scatterings, so far neglected, was evaluated to be, except at large values of the dechanneled fraction, a small correction to the steady-increase description. (auth)

59131 THEORY OF DEFECTS IN IRRADIATED SEMICONDUCTORS. Stoneham, A. M. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 9: No. 3-4, 165-71(Jun 1971). (CONF-700824-39).

From International conference on radiation effects and semiconductors; Albany, N. Y. (24 Aug 1970).

Developments in the theory of defects in semiconductors are reviewed, with emphasis on changes since the Santa Fe meeting and on the points that were controversial then. It has become clear that most of the desirable simplifications are invalid for vacancies in diamond and silicon, and probably also for similar systems. In particular, one cannot use the one-electron approximation, the rigid-lattice approximation, or the Jahn–Teller instability with coupling within isolated levels alone, nor some of the conceptually acceptable treatments of the lattice distortion. The successes and weaknesses of the various approaches are reviewed, and some of the potential methods are described. (58 references) (auth)

59132 LOW-TEMPERATURE ANNEALING OF ELECTRON-IRRADIATED GERMANIUM. Hyatt, W. D.; Koehler, J. S. (Univ. of Illinois, Urbana). Radiat. Eff.; 9: No. 3-4, 177-9(Jun 1971). (CONF-700824-40).

From International conference on radiation effects and semiconductors; Albany, N. Y. (24 Aug 1970).

N-type germanium (4×10^{14} Sb/cm^3) was irradiated with 1.1-MeV electrons at 5°K. The defects produced were studied by measuring the voltage-dependent capacitance of a metal/germanium junction at the surface of a germanium sample. These measurements were made at 10°K and directly gave the fixed charge density near the surface of the sample. The production and recovery of defects seen near the surface is the same as seen in bulk experiments. A 0.5-MeV electron beam was used to cause radiation annealing of the defects at 5°K. The fraction recovered during radiation annealing is directly proportional to $\sqrt{t}$. A model based on diffusion-limited recovery theory is used to explain these results. This model is also used to discuss the results of previous experiments. The temperature dependence of the observed recovery at 5°K gave a defect migration energy of 0.0044 ± 0.0008 eV. (auth)

59133 DONOR–VACANCY TYPE COMPLEXES IN GERMANIUM. Emtzev, V. V.; Mashovets, T. V.; Maximov, M.; Vitovskii, N. A. (Ioffe Inst. of Physics and Tech., Leningrad). Radiat. Eff.; 9: No. 3-4, 181-7(Jun 1971). (CONF-700824-41).

From International conference on radiation effects and semiconductors; Albany, N. Y. (24 Aug 1970).

Very unusual energy spectra and defect production kinetics were observed under ^{60}Co γ irradiation and heat treatment of high-purity germanium. The results can be explained in terms of vacancy–donor and divacancy–donor complexes. The upper limit of the vacancy migration energy in germanium is estimated as 0.3 eV. (auth)

59134 PHONON SCATTERING AND INDUCED ENERGY LEVELS IN ELECTRON-IRRADIATED Sb-DOPED Ge IN THE n TO p-TYPE CONVERSION REGION. Laurence, G.; Albany, H. J. (CEN de Saclay, Gif-sur-Yvette, France). Radiat. Eff.; 9: No. 3-4, 189-94(Jun 1971). (CONF-700824-42).

From International conference on radiation effects and semiconductors; Albany, N. Y. (24 Aug 1970).

Low-temperature thermal conductivity results on Sb-doped Ge irradiated at ~40°C by 4-MeV electrons are reported. The change in K upon electron dose Φ was investigated in the n to p-type conversion region for two Sb concentrations, 8.4×10^{15} and 4.5×10^{17} cm^{-3}. The thermal conductivity behavior was shown to arise from electron–phonon scattering in relation to antimony levels, irradiation-induced energy levels, and their charge states. The different stages of K variation emphasize the dominant effects of the induced levels determined from Hall-effect measurements. The existence of a residual scattering near the n–p transition appears to be a striking feature that might indicate a particular role or structure for the acceptor centers in this region. (auth)

59135 DEFECTS IN SILICON: CONCEPTS AND CORRELATIONS. Stein, H. J. (Sandia Labs., Albuquerque, N. Mex.). Radiat. Eff.; 9: No. 3-4, 195-210(Jun 1971). (CONF-700824-43).

From International conference on radiation effects and semiconductors; Albany, N. Y. (24 Aug 1970).

A review of irradiation-produced defects in Si is presented, with emphasis on correlations of macroscopic properties with microscopic defects. Such correlations have been successfully used to interpret the electrical properties of irradiated n-type Si. Additional correlation studies are needed to obtain a more complete interpretation of the electrical properties of irradiated p-type Si. As a further step in this direction, new data are presented on the annealing recovery of the hole concentration in electron-irradiated Al-doped and B-doped Si. The concept of vacancy-rich defect clusters, together with concepts and data on point defects, explain many aspects of neutron radiation damage. The same defects, concepts, and correlations used in studies of electron- and neutron-produced damage are also useful for interpreting radiation damage produced by ion implantation. (94 references) (auth)

59136 STUDY OF ATOMIC DISPLACEMENTS IN He$^+$-IRRADIATED SILICON AND A SILICON–GERMANIUM ALLOY THROUGH RUTHERFORD SCATTERING. Baruch, P. (Ecole Normale Superieure, Tours, France); Abel, F.; Cohen, C.; (and others). Radiat. Eff.; 9: No. 3-4, 211-17(Jun 1971). (CONF-700824-44).

From International conference on radiation effects and semiconductors; Albany, N. Y. (24 Aug 1970).

The disorder created by He$^+$ ions of 275 keV and 1610 keV in Si and in a Si–Ge alloy (0.6 at. % Ge) was studied at 295 and 85°K through the use of channeling and backscattering of these ions. The disorder is measured through the relative yield of backscatter for the beam incident in $\langle 111 \rangle$ and $\langle 110 \rangle$ directions. In both crystals, the disorder is not linear with fluence, and shows a tendency to saturate. In many cases the disorder measured along $\langle 110 \rangle$ channels is larger than along $\langle 111 \rangle$ channels, which indicates a prevalence of interstitial-type defects. However, there is no indication of the structure of the defects. Part of the disorder could be attributed to slight displacements of atoms in the strain field of radiation defects. The low-temperature irradiations create more disorder than room-temperature irradiations, and this excess disorder does not fully anneal at 120°C. In Si(Ge), the number of Si or Ge scatterers is close to the concentration ratio even at high fluences. This shows there is no preferential process by which Ge interacts with Si defects. (auth)

59137 RADIATION-INDUCED DEFECTS IN DIAMOND. Clark, C. D.; Mitchell, E. W. J. (Univ. of Reading, Eng.). Radiat. Eff.; 9: No. 3-4, 219-34(Jun 1971). (CONF-700824-45).

From International conference on radiation effects and semiconductors; Albany, N. Y. (24 Aug 1970).

A critical review of radiation damage in diamond is presented, focusing on important specific centers rather than attempting a review of the whole field. The proposed models for these centers are examined and often found wanting. Phenomena observed in ion bombardment of diamond is discussed and found to probably be due to amorphous or graphite surface layers. Throughout the review, a number of suggestions of important experiments are given. (75 references) (auth)

59138 III–V COMPOUND REVIEW. Eisen, F. H. (North American Rockwell Science Center, Thousand Oaks, Calif.). Radiat. Eff.; 9: No. 3-4, 235-42(Jun 1971). (CONF-700824-46).

From International conference on radiation effects and semiconductors; Albany, N. Y. (24 Aug 1970).

Radiation effects in InSb, GaSb, and GaAs are reviewed with emphasis on damage production and comparison of recovery results. The orientation dependence of damage production at electron energies near threshold, the rather low values of the threshold displacement energy, and subthreshold damage effects are discussed. Consideration is given to a number of similarities in the recovery data for InSb and GaSb, and some differences between these materials and GaAs are discussed. (27 references) (auth)

59139 LUMINESCENCE OF IRRADIATED β–SiC. Geiczy, I. I.; Nesterov, A. A.; Smirnov, L. S. (Inst. of Semiconductor

Physics, Novosibirsk, USSR). Radiat. Eff.; 9: No. 3-4, 243-6 (Jun 1971). (CONF-700824-47).

From International conference on radiation effects and semiconductors; Albany, N. Y. (24 Aug 1970).

The influence of electron irradiation with energy of 3.5 MeV on the luminescence of cubic silicon carbide (β-SiC) was investigated. It was shown that irradiation results in the diminution of edge emission and appearance of the red band (2.0 to 1.3 eV). The obtained results give an opportunity to consider the red band as transitions from exicted states. The data on temperature stability of irradiated damage is given. The probable nature of irradiated defects are discussed. (auth)

59140 DAMAGED REGIONS IN NEUTRON-IRRADIATED AND ION-BOMBARDED Ge AND Si. Swanson, M. L.; Parsons, J. R.; Hoelke, C. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Radiat. Eff.; 9: No. 3-4, 249-56(Jun 1971). (CONF-700824-48).

From International conference on radiation effects and semiconductors; Albany, N. Y. (24 Aug 1970).

The formation of amorphous or crystalline damaged regions by ion bombardment or neutron irradiation of Ge and Si is discussed. Several experiments have demonstrated that Ge and Si become amorphous when bombarded to high fluences with ions of 20 to 200 keV energy, but remain crystalline after low ion fluences ($<10^{14}/cm^2$) or after fission neutron irradiations up to very high fluences. The present results indicate that a fission neutron fluence of 5×10^{20} n/cm^2 at ~50°C and at a flux of 6×10^{13} n/cm^2/sec produces no amorphism in Ge or Si, but that microcrystals appear after annealing at 450°C. It is concluded that the individual damaged regions produced by high-energy ions or by primary knock-on atoms from fission-neutron collisions are crystalline. When these damaged regions are created rapidly enough so that overlap occurs before appreciable annealing of point defects takes place, the damaged regions become amorphous. The critical defect concentration required for spontaneous transformation to amorphism is estimated to be 0.02. (auth)

59141 PREFERENTIAL ETCHING OF ION-BOMBARDED GaAs. Arnold, G. W.; Whan, R. E.; Maurin, J. K.; Borders, J. A. (Sandia Labs., Albuquerque, N. Mex.). Radiat. Eff.; 9: No. 3-4, 257-60(Jun 1971). (CONF-700824-49).

From International conference on radiation effects and semiconductors; Albany, N. Y. (24 Aug 1970).

Abrupt changes in the near-band-edge luminescence of n-type undoped GaAs after implantation with 400-keV Zn ions and vacuum annealing at 580°C are reported. The good agreement of the spectral position, half-width, and temperature dependence of the emission obtained after implantation and annealing with that of melt-doped GaAs : Zn indicates that implanted Zn ions were incorporated at Ga lattice sites. The larger number of Zn substitutions obtained when bombardment is made on the Ga face than for an equivalent fluence on the As face demonstrates the existence of a polar implant effect. (auth)

59142 RECOVERY OF RHENIUM FOLLOWING LOW-TEMPERATURE ALPHA-PARTICLE IRRADIATION. von Heyden, G.; Vandenborre, H.; Stals, L.; Nihoul, J. (SCK/CEN, Mol, Belg.). Radiat. Eff.; 9: No. 3-4, 279-81(Jun 1971).

A resistometric study was made of the annealing recovery of pure polycrystalline Re following irradiation at 5°K by ^{242}Cm sources. The results are compared with these for thermal-neutron irradiation at 3.7°K (Coltman et al., Phys. Rev. 156: 715(1967)). The alpha-particle-induced resistivity was 20 to 30 nΩ cm, an order of magnitude larger than from thermal neutrons. The first resolvable recovery peak is I_3 at 32°K, and the I_6 stage is split up into three or four substages at 73 to 97°K. (D.L.C.)

59143 ALPHA- AND BETA-MAGNETIC EFFECTS IN HOMOGENEOUS GERMANIUM MONOCRYSTALS. Simonenko, D. L. At. Energ. (USSR); 31: No. 3, 237-8(Sep 1971). (In Russian).

A novel physical phenomenon is described that occurs when the surface of a homogeneous (junction-free) Ge crystal, resting in a permanent magnetic field, is irradiated with α or β particles. (The α and β sources used in the experiments were a ^{238}Pu preparation and a ^{90}Sr-^{90}Y preparation, respectively.) A difference of potential arises which is directed along the plate, i.e., perpendicular to the direction of the magnetic field and the direction of the beam of bombarding particles. (K.S.W.)

59144 COMPARISON OF DISPLACEMENT RATES PRODUCED BY ION BOMBARDMENT AND NEUTRON IRRADIATION. Doran, D. G. (WADCO Corp., Richland, Wash.); Kulcinski, G. L. Contracts AT(45-1)-2170; AT(45-1)-1830. Radiat. Eff.; 9: No. 3-4, 283-4(Jun 1971).

Refinements are made of estimates (Kulcinski et al., Radiat. Eff., 7: 195(1971)) of atom displacement rates for comparison of ion bombardment and neutron irradiation in stainless steel. The ratio of the energy lost by knock-on atoms in nuclear collisions to the energy lost in primary nuclear collisions was calculated for Cu ions with incident ion energies of 1 and 5 MeV and several energy transfer values. The approximate EBR-II neutron fluence (E > 0.1 MeV) required to produce the same number of displaced atoms as 2×10^{16} ions/cm^2 was calculated to be 3×10^{22} n/cm^2. (D.L.C.)

59145 ATOMIC INTERACTION POTENTIAL FOR NICKEL. Kaletta, D. (Kernforschungszentrum, Karlsruhe, Ger.). pp 319-22 of Voids Formed by Irradiation of Reactor Materials. /Pugh, S. F. (ed.). London; British Nuclear Energy Society (1971).

From Voids formed by irradiation of reactor materials conference; Reading, England (24 Mar 1971).

An inverse power interaction potential V_{inv} (r) = $(Z_1Z_2e^2/sr^s)$ a_{inv}^{s-1}; $1 \leq s < \alpha$ was used to determine the displacement cross section and the range of bombarding ions in a polycrystalline target. A random structure for the target was assumed and classical mechanics employed throughout. The construction of the interaction potential from low-energy values (≥25 eV) to high values (≤100 MeV) was achieved both from using the Born-Mayer potential of the target and by superposing the Born-Mayer and the Bohr potentials. The screening length a_{inv} and the exponent S were calculated using a semi-empirical procedure. An advantage of a simple potential with only two semi-empirically determined parameters is that errors are made minimal. (UK)

59146 ENERGY DEPENDENCE OF SECONDARY-ELECTRON EMISSION IN CRYSTALS. Zommerfel'dt, Kh.; Mashkova, E. S.; Molchanov, V. A. (Moscow State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 3, 676-9(Sep 1971).

Translated from Fiz. Tverd. Tela; 13: No. 3, 819-23(Mar 1971).

The energy dependence of the secondary electron emission coefficient of germanium crystals bombarded by ions of an inert gas is studied experimentally. The observed relations are discussed on the basis of ion channeling in crystals. The accepted model makes it possible to explain the smoothing of the angular dependence of the secondary electron emission coefficient at lower ion energies and to evaluate the contribution of channeled ions to emission. (auth)

59147 OSNOVY RADIATSIONNOGO MATERIALOVEDENIYA STEKLA I KERAMIKI. (Radiation Effects on Glass and Ceramics). Brekhovskikh, S. M.; Viktorova, Yu. N.; Grinshtein, Yu. L.; Landa, L. M. Moscow; Izdatel'stvo Literatury po Stroitel'stvu (1971). 256p.

The effects of types and doses of radiation on the various properties of glass and ceramics are presented. The optical absorption in glasses of simple composition and radiation-optical stability of industrial glasses are considered. Other chapters focus attention on the formation and destruction of color centers, luminescence, and resonance absorption in glasses. Radiation effects on the electrical properties of glass and ceramics and on the structure of materials (density, volume, and phase composition) are discussed. Absorbers of hard radiation and thermal neutrons are reviewed, accompanied by a summary of radiation-sensitivity of materials, particularly as applied to the construction of dosimeters and scintillators. (516 references) (K.S.W.)

59148 SPECIFIC HEAT OF NEUTRON IRRADIATED GRAPHITE BETWEEN 1.4 AND 4.4 °K IN THE PRESENCE OF A VARIABLE MAGNETIC FIELD (0 TO 40 kGs). Delhaes, Pierre; Lemerie, M. Y.; Blondet-Gonte, Gilbert (CNRS, Talence, France). Compt. Rend., Ser. B; 272: No. 23, 1285-8(7 Jun 1971). (In French).

The specific heat of heavily irradiated graphite was measured in the presence of a variable magnetic field; a magnetic component of the specific heat, linked with the existence of stable paramagnetic centers, is established. (France)

59149 BREMSSTRAHLUNG FROM 7- TO 10-MeV ELECTRONS IN THIN SILICON CRYSTALS. Komar, A. P.; Korobochko, Yu. S.; Mineev, V. I.; Petrochenko, A. F. (Leningrad Polytechnic Inst.). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 631-6 (Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 807-14(Apr 1971).

An experimental study was made of bremsstrahlung spectra from single-crystal silicon targets 7 to 11 μ thick bombarded with 7 to 10 MeV electrons in the [110] direction. The heights of the coherent peaks relative to the incoherent part of the spectrum are in satisfactory agreement with the calculated values. (auth)

59150 DISTRIBUTION OF ENERGY LOSSES FOR HEAVY POSITIVE PARTICLES IN A SINGLE CRYSTAL. Kalashnikov, N. P.; Remizovich, V. S.; Ryazanov, M. I. (Moscow Engineering

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Physics Inst.). JETP Lett. (USSR) (Engl. Transl.); 13: No. 12, 508-10(20 Jun 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 12, 715-18(20 Jun 1971).

For the case of channeling of heavy particles in a single crystal, an approximation of the energy losses is derived in which the inelastic processes are described in a very simple manner. Channeled particles lose an energy smaller by a factor

$$\left(1 - \ln\frac{v}{e^2\sqrt{Z_1^{2/3} + Z_2^{2/3}}} \Big/ \ln\frac{2m_e v^2}{l_z}\right)$$

than the nonchanneled ones. The distribution function of the energy loss is in agreement with the experimental results of C. Erginsoy for protons in Si single crystals, with the loss of channeled particles being 0.45 of that of unchanneled ones (calculated factor = 0.5). (D.L.C.)

59151 APPLICATIONS OF THE CHANNELLING AND BLOCKING EFFECTS. **Czegledy, Sandor (Nuclear Research Inst., Debrecen, Hungary). Atomtech. Tajek.; 13: No. 8, 473-8(Dec 1970). (In Hungarian).**

The channeling effect is an old and forgotten phenomenon that has been recently rediscovered. It is based on channels lying in specific directions within the crystals, created by the low Miller index crystal planes. If a beam of charged particles is directed against the crystal in a direction parallel with the axis of the channel, the energy loss of the particles resulting from interaction with the atoms at the channel wall will be decreased. The blocking effect is the opposite phenomenon, involving blockage of the passage of particles in certain directions. These two effects influence the radiation damage of ion implantation occurring during ionic bombardment. The effect may be used to determine the lifetime of intermediate nuclei on the basis of its recoil velocity. The blocking effect may also be used to determine the relative vibration amplitude of lattice vibrations. Both effects promise to become an important tool for atomic and solid-state physics. (22 references). (TTT)

59152 F-AGGREGATE CENTERS IN SODIUM CHLORIDE. I. **Jun, Moo Jin; Neubert, Theodore J. (Illinois Inst. of Tech., Chicago). J. Chem. Phys.; 55: No. 4, 1583-7(15 Aug 1971).**

Thermal aggregation of electron-excess color centers in NaCl, x-irradiated at 80°K, was studied by observation of changes in optical absorption in pulse annealing experiments. An initial 80-hr x irradiation introduced large concentrations of F, F′, and positive hole centers. As annealing temperatures were raised (80 → 235°K), recombination of thermally released positive holes with electrons in F centers produced α centers. Thermal aggregation of F centers occurred above 240°K when α centers become mobile. M^+ centers (F_2^+) form and disappear and M centers (F_2) increase rapidly in number near 265°K as a result of the reactions $F + \alpha \rightarrow F_2^+$ and $F_2^+ + e \rightarrow F_2$, R^+ centers (F_3^+) form by the reaction $F_2 + \alpha \rightarrow F_3^+$ below 320°K and disappear slowly by the reactions $F_3^+ + e \rightarrow F_3$ and $F_3^+ + \text{heat} \rightarrow F_2 + \alpha$, above 330°K. Optical absorption band maxima at 80°K are: M^+, 1.22 eV (1015 nm); M_1, 1.74 eV (713 nm); R^+, 1.80 eV (690 nm); R_1, 2.28 eV (543 nm); and R_2, 2.07 eV (600 nm). N_1 and N_2 band systems were observed but were not studied in any detail. M^+ centers also were formed by direct ionization of M centers by 300-nm light. The concentration, however, was low because of a counterbalancing of photoionization and electron capture processes. R^+ centers were formed in x-irradiated NaCl by excitation with light absorbed in the R_2 band. They could be transformed back to R centers by x irradiation or F center bleaching. (auth)

59153 EVIDENCE FOR STATIC CROWDIONS IN ELECTRON-IRRADIATED Au-15 AT. PERCENT Ag ALLOYS. **Schuele, W. (EURATOM, Ispra, Italy); Frank, W.; Seeger, A. Radiat. Eff.; 10: No. 1-2, 123-7(Jul 1971).**

It is shown that recent investigations by Sprušil, Haas, and Wollenberger on the low-temperature electron irradiation and the recovery of the electrical resistivity of Au−15 at.% Ag alloys may be easily explained in terms of the two interstitial model. These results indicate in a rather specific way that, in this alloy, defect migration in stage I takes place one-dimensionally. It is concluded that none of the models that assume three-dimensional migration for the interstitial migrating at low temperatures are capable to account for the recovery behavior of Au−15 at.% Ag alloys. (auth)

59154 EFFECT OF NEUTRON AND ALPHA-PARTICLE IRRADIATION UPON THE PHYSICAL PROPERTIES OF α-SiC. Barinov, Y. V.; Bulgakov, Y. V.; Iglitsyn, M. I.; (and others) (Giredmet, Moscow). Radiat. Eff.; 10: No. 1-2, 111-15(Jul 1971).

Alpha-particle (25 MeV) and neutron irradiation of sublimation-grown α-SiC was carried out. A new EPR spectrum was observed but no model was established for the defect responsible for this spectrum. IR absorption (0.4 to 25 μ) was also studied; no distinct bands were observed beyond a broad near-edge nonselective absorption. (auth)

59155 INFRARED ABSORPTION STUDIES IN NEUTRON- AND ELECTRON-IRRADIATED GaAs. **Vaidyanathan, K. V.; Watt, L. A. K. (Univ. of Waterloo, Ont.). Radiat. Eff.; 10: No. 1-2, 99-106(Jul 1971).**

Mechanically and chemically polished samples of GaAs were irradiated with fission neutrons to fluences varying from 2×10^{16} to 1.4×10^{18} neutrons/cm^2 and with 1.5-MeV electrons with doses varying from 10^{17} to 10^{18} el/cm^2. Infrared absorption in irradiated crystals was measured at 300 and 85°K. In neutron-irradiated samples absorption bands centered at 0.47 eV and at 0.25 eV were observable. It is suggested that the 0.47 eV band is connected with transitions from a level at ($E_c - 0.5$) eV reported earlier from electrical measurements. The absorption coefficient was found to vary linearly with the square of the photon energy over a limited energy range. For electron-irradiated GaAs, the absorption in the band gap had an exponential variation with energy. Possible reasons for such a behavior are discussed. The absorption spectrum at 85°K in electron-irradiated samples showed the presence of a band at 1.0 eV. Isothermal and isochronal annealing behavior of this absorption band was studied. An analysis of data suggests that the recovery obeys first order kinetics with an activation energy of 0.88 ± 0.07 eV. (auth)

59156 ANNEALING BEHAVIOR OF BULK n-GaAs IRRADIATED BY ELECTRONS AT 77°K. **Jeong, M. U.; Shirafuji, J.; Inuishi, Y. (Osaka Univ.). Radiat. Eff.; 10: No. 1-2, 93-8 (Jul 1971).**

The annealing behavior of electrical properties and photoluminescence spectra both at 77°K in electron-irradiated melt-grown n-GaAs were investigated. Defects electrically active in the Hall mobility and carrier removal anneal through two stages centered at 250 and 460°K. From the temperature dependence of carrier concentration the existence of a defect level located near 0.15 eV below the conduction band is supposed. Several emission bands are resolved at 1.51, 1.47, 1.415, 1.305, and ~1.2 eV in photoluminescence experiments. Electron irradiation (1.5 to 2.0 MeV) caused a remarkable decrease in emission intensity of 1.51 and ~1.2 eV bands. Recovery of emission intensity occurred remarkably when samples were annealed to 520°K, which would correspond to the 460°K annealing stage for carrier concentration and Hall mobility. The 250°K annealing stage was not observed in photoluminescence experiments. The 1.415-eV peak appeared clearly after irradiation and grew remarkably with the 520°K annealing, especially in Si-doped samples, resulting in large reverse annealing. This band was tentatively speculated to be a complex of Si on As site with As vacancy. Moreover, in samples doped with Te a new emission band at 1.305 eV (9500 Å) was observed after 470 to 620°K annealing. (auth)

59157 COMMENTS ON THE SCATTERING OF CHARGED PARTICLES BY SINGLE CRYSTALS. I. THE GENERAL CASE. **Newton, C. S. (Oersted Inst., Copenhagen); Chadderton, L. T. Radiat. Eff.; 10: No. 1-2, 33-42(Jul 1971).**

The scattering of a beam of fast charged particles by a single crystal lattice is discussed in detail and a qualitative picture drawn of the quantum/classical transition. (auth)

59158 INFLUENCE OF THE DOSE OF IRRADIATION ON THE RECOVERY OF RESISTIVITY OF α IRRADIATED Al FOILS. **Trieb, L.; Siebinger, K. (Univ., Vienna). Z. Metallk., 62: No. 9, 682-4(Sep 1971). (In German).**

Technically pure Al foils (99.5%; main impurities 0.24% Fe, 0.09% Si, of 5.5 μm thickness) were irradiated with α particles from ^{210}Po at 78°K and the changes in electrical resistivity were measured. Three discrete recovery stages were found whose centers occurred at 115 and 160°K (stage II) and 220°K (stage III), respectively. The activation energy of stage III was found to be E = 0.58 eV. Details of the recovery curves resembled those of neutron irradiated specimens. (auth)

59159 PROCESSES OF FORMATION AND ANNEALING OF RADIATION DEFECTS IN GERMANIUM, IRRADIATED BY HIGH ENERGY PROTONS. **Konopleva, R. F.; Novikov, S. R.; Rubinova, E. E. (Ioffe Inst. of Physics and Tech., Leningrad). Radiat. Eff.; 10: No. 1-2, 117-22(Jul 1971).**

The rate of damage formation, the spectrum of energy levels, and the annealing results on n- and p-type Ge irradiated by 600-MeV protons were studied and compared to similar results on

γ-irradiated samples. Reverse annealing (and defect creation) was found upon the decay of disordered regions. The formation upon annealing of complexes with impurities is also deduced. (auth)

59160 STIRLING CYCLE CRYOGENIC COOLER USED WITH ACCELERATOR FOR RADIATION EFFECTS IN THIN FILMS. Pronko, P. P.; Hardy, W. R.; Shewchun, J. (McMaster Univ., Hamilton, Ont.). Radiat. Eff.; 10: No. 1-2, 79-85(Jul 1971).

A new approach is presented relating to the adaptation of a miniature closed-cycle cooler and its associated control equipment to accelerator-produced low-temperature radiation effects in solids. The cooler is capable of operating between 20 and 300°K with temperature control of 0.02°K within this interval. The system has been used with beams of 150-keV protons on thin films of oxygen- and nitrogen-doped tantalum, where changes in film conductance are used as a measure of the damage effects. A description of the cryogenic system is presented along with operational characteristics. Typical results are also presented for conductivity–fluence measurements, isochronal annealing, and radiation effects on temperature coefficient of resistivity. (auth)

59161 RADIATION EFFECTS IN CdTe INDUCED BY THERMAL NEUTRONS AND 1 MeV ELECTRONS. Abramov, A. A.; Vavilov, V. S.; Vodopyanov, L. K. (Lebedev Inst. of Physics, Moscow). Radiat. Eff.; 10: No. 1-2, 107-10(Jul 1971).

Neutron and electron bombardments of n- and p-type CdTe were carried out. Carrier concentration, Hall mobility, and photoconductivity were measured. Energy levels at $E_c - 0.06$ eV and $E_v + 0.17$ eV were found and are attributed to complicated centers, including the Cd vacancy. (auth)

59162 COMMENT ON EVIDENCE FOR STATIC CROWDIONS IN ELECTRON-IRRADIATED Au-15 AT. PERCENT Ag ALLOYS BY W. SCHUELE, W. FRANK, AND A. SEEGER. Wollenberger, H. (Kernforschungsanlage, Juelich, Ger. Technische Hochschule, Aachen). Radiat. Eff.; 10: No. 1-2, 135-6(Jul 1971).

Further comments are added to the earlier paper of the authors (Radiat. Eff., 10: 123-7(1971)). These comments discuss disordering, alloying effects, trapping role of Ag, defect migration, etc. One of the three recovery models cannot explain the recovery behavior of electron-irradiated Au−15 at.% Ag alloys. (D.L.C.)

59163 INTERACTION BETWEEN RADIATION DAMAGE AND COHERENT PRECIPITATES. Woolhouse, G. R.; Ipohorski, M. (Cavendish Lab., Cambridge, Eng.). Proc. Roy. Soc. (London), Ser. A; 324: No. 1559, 415-31(21 Sep 1971).

The experiments of Brown, Woolhouse, and Valdrè (Phil. Mag., 17: 781(1968)) on coherency loss induced by fast-neutron irradiation were extended by varying the precipitate size distribution, the fast-neutron dose, and the mismatch of the precipitate. When the integrated dose and the mean precipitate size are large, coherency loss is extensive during irradiation. Otherwise, thermal activation is required for coherency loss. This is shown to be consistent with a process involving the unfaulting of interstitial dislocation loops and their subsequent glide and climb to the precipitate interfaces. Closer agreement is found with the theoretically predicted critical size for coherency loss of Brown et al. Experiments involving coherency loss by electron irradiation in a high-voltage electron microscope are also described. It is found that, in this case, coherency loss occurs by the migration of free interstitial atoms produced by the irradiation and very close agreement with the theoretically predicted size is found. (auth) (UK)

59164 EFFECTS OF PRIOR ELECTROLYSIS ON THE KINETICS OF F-CENTRE GROWTH IN IRRADIATED NaCl. Montojo, M. T.; Jaque, F. (Junta de Energia Nuclear, Madrid). Solid State Commun.; 9: No. 18, 1595-7(15 Sep 1971).

NaCl crystals subjected to an electric field at high temperatures were subsequently irradiated with γ rays at room temperature. It was found that the first stage of the F curve was not affected while the length of stage II decreased and the coloring corresponding to stage III increased appreciably. This effect can be attributed to creation of nuclei for interstitial aggregation during the electrolytic treatment. (auth) (UK)

59165 CHANNELING. Thompson, M. W. (Univ. of Sussex, Brighton, Eng.). pp 223-36 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

A general review of channeling and blocking phenomena includes basic explanations and illustrations of the phenomena, diagrams of typical experiments, and brief discussions of classical and quantum mechanical theories of channeling. (A.G.W.)

59166 INTRODUCTION TO ION IMPLANTATION. Davies, J. A. (Univ. of Aarhus, Denmark). pp 237-66 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Existing experimental techniques for range measurements in ion implantation and the particular advantages and limitations of each are reviewed. Existing range data in amorphous and crystalline targets are summarized and correlated with theory wherever possible. The role of channeling in ion implantation in monocrystalline targets is considered. Anomalous penetration effects due to various types of enhanced-diffusion processes are discussed briefly. (58 references) (A.G.W.)

59167 CHANNELING-EFFECT TECHNIQUE FOR STUDYING ATOMIC LOCATIONS WITHIN THE CRYSTAL LATTICE. Davies, J. A. (Univ. of Aarhus, Denmark). pp 267-95 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

The general principles of the channeling phenomenon are reviewed. Techniques for application of channeling as a tool for determination of the amount of lattice disorder in crystals and the distribution of implanted atoms between substitutional and various interstitial sites are discussed. A brief summary of results of such studies is included. (30 references) (A.G.W.)

59168 ION IMPLANTATION OF BINARY III–V SEMICONDUCTORS. Carter, G.; Aiers, M.; Grant, W. A.; (and others). (Univ. of Salford, Eng.). pp 296-325 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

Studies of the basic physical parameters involved in effective ion implantation of binary III–V semiconductors are reviewed. These studies deal with depth profiles of implanted ions, the nature and extent of the radiation damage created by implantation, the possibilities of minimizing this radiation damage, and the location of implanted ions within the lattice. Electrical behavior of implanted materials is discussed briefly. (37 references) (A.G.W.)

59169 DECHANNELING OF PARTICLES BY LATTICE DEFECTS. Quere, Y. (CEN, Fontenay-aux-Roses, France). pp 392-407 of Physics of Ionized Gases. /Navinsek, B. (ed.). Ljubljana, Yugoslavia; Institut Jozef Stefan (1970).

From 5th Plasma Physics Symposium, Hercegnovi, Yugoslavia. See CONF-700706.

All lattice defects tend to dechannel channeled particles. The dechanneling probability is generally a function of the energy of the channeled particle, of the distance to the defect, and of the family of axial (or planar) channels involved. Some theoretical predictions are given in the case of dislocations and stacking faults. Experimental evidences of dechanneling are presented for boundaries, dislocations, stacking faults, Guinier–Preston zones, etc. (auth)

59170 ACCUMULATION OF RADIATION DEFECTS IN RADIOACTIVE SAMPLES. Gromov, V. V. (Inst. of Physical Chemistry, Moscow). High Energy Chem. (USSR) (Engl. Transl.); 3: No. 5, 400(Sep-Oct 1969).

Translated from Khim. Vys. Energ.; 3: No. 5, 444-5(Sep-Oct 1969).

Under the action of self-radiation in radioactive solid bodies various defects accumulate, such as radical ions, color centers, and dislocated atoms. Analogous changes also occur during the external irradiation of nonradioactive samples. However, in the former case, the self-radiation intensity (the quantity of radioactive isotope) can change significantly with time, which must substantially affect the kinetics of radiation-defect accumulation. Formulation is given for a case when the accumulation and annealing of radiation dislocations is a monomolecular process in which the intensity of irradiators varies according to an expression relating the dislocation concentration to time. (auth)

59171 DISORDER PRODUCED IN SiC BY ION BOMBARDMENT. Hart, R. R.; Dunlap, H. L.; Marsh, O. J. (Hughes Research Labs., Malibu, Calif.). Radiat. Eff.; 9: No. 3-4, 261-6(Jun 1971). (CONF-700824-50).

XUM

From International conference on radiation effects and semiconductors; Albany, N. Y. (24 Aug 1970).

The amount of residual lattice disorder produced in $\alpha-$SiC after implantation of 40-keV Sb^+ and 30-keV N^+ was measured. The implantations were performed at 23°C and, to avoid channeling effects, at a preselected random-equivalent orientation of the target with respect to the ion beam. The disorder, defined as the number of lattice atoms displaced greater than ~0.2Å from lattice sites, was determined by backscattered energy analysis of 280-keV He^{2+} and 140-keV H^+ incident along the ⟨0001⟩ channel and in a random direction. The amount of disorder increased linearly with dose of the heavy ion (Sb^+) to a saturation condition, corresponding to the formation of an amorphous layer at a dose of $\sim 10^{14}$ Sb^+/cm^2. The disorder produced by the light ion (N^+) at first increased as the square root of N^+ dose but at $\sim 10^{14}$ N^+/cm^2 increased approximately linearly with dose to a saturation value at $\sim 10^{15}$ N^+/cm^2. Similar behavior for these two ions has been observed in Si. The number of displaced atoms of Si and C produced by an Sb ion is ≈2400. Comparison of this result with Sb ion displacement in Si indicates a displacement energy E_d for SiC for 17- to 30-eV. A significant annealing of lightly disordered regions in the Sb^+ and N^+ implanted layers is observed after 500°C. More heavily damaged layers anneal at 750°C and above. Little disorder remains after a 1200°C anneal. Annealing at 1650°C or greater produces evidence of decomposition, although there are indications that the implanted species inhibits further decomposition. There is no evidence of outdiffusion of Tl after 1650°C anneal and only slight evidence of outdiffusion of Sb after 1700°C anneal. Channeling analysis of Sb^+ implants after a 1500°C anneal that ~50% of the Sb ions are located along the ⟨0001⟩ atomic rows. (auth)

59172 ELECTRIC CONDUCTIVITY OF ELECTRON-IRRADIATED MONOCRYSTALS OF KCl–RbCl SOLID SOLUTIONS. Zavadovskaya, E. K.; Grishukov, V. A.; Cholokov, K. S. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 12, 92-6(1970). (In Russian).

The influence of divalent cation impurities on the radiation-induced changes of electric conductivity of RbCl crystals and KCl−RbCl solid solutions when irradiated by 1.2-MeV electrons of current strength 1.86 to 7.44 × 10^{15} el/cm^2 was studied. It was found that at 20 to 550°C, the temperature dependence of electric conductivity has, in general, a complex form. In the case of crystals free of divalent impurities, not only is the radiation decrease of conductivity from the Smoluchowski mechanism absent, but there is observed a sharp increase. The physical processes that lead to the appearance of maxima in the temperature dependence of electric conductivity of irradiated crystals are considered. (tr-auth)

59173 EFFECT OF ION BOMBARDMENT ON SEMICONDUCTORS. Abroyan, I. A. (Leningrad Polytechnic Inst.). Usp. Fiz. Nauk; 104: No. 1, 15-50(May 1971). (In Russian).

Change in physical properties of semiconductors resulting from ion bombardment and introduction of various types of defects are reviewed. Types of defects and methods of investigating structural disturbances in semiconductors are described. The bulk of the discussion is concerned with changes in the electrical properties by ion bombardment: creation of p−n junctions, electric conductivity of layers obtained by ionic alloying, and diffusion occurring during irradiation. Radiation conductivity and luminescence during bombardment with electrons and ions and effects on optical and other properties are included. 217 references. (K.S.W.)

59174 ELECTRON SPIN RESONANCE STUDIES OF INTRINSIC AND IMPURITY DEFECTS IN SILICA AND GERMANIA. Garlick, G. F. J.; Nicholls, J. E.; Prasad, C.; Oezer, A. M. (Univ. of Hull, Eng.). Phys. Chem. Glasses; 12: No. 4, 102-4(Aug 1971).

The occurrence of electron spin resonance due to intrinsic defects in silica and germanium was investigated by other workers. In the present studies the effects of heat treatment in controlled ambients on impurities caused by high-energy electron bombardment were investigated using spin resonance and thermal annealing techniques. A new center was found in silica doped with hydrogen involving an electron trapped at a silicon site with an adjacent hydrogen atom which imposes a characteristic hyperfine structure. In germanium dioxide, centers due to oxygen vacancy−interstitial oxygen pairs with an associated impurity ion were found. Threshold energies for displacement of network oxygen were determined by high-energy electron bombardment. Electron spin resonance signals characteristic of intrinsic and impurity defects in silica and in zinc oxide were used to follow the transfer or removal of these defects when the two oxides were used to synthesise zinc orthosilicate. Such techniques offer a powerful tool in the study of such syntheses and may be extended to follow the stages of formation of silicate glasses and crystals. (auth) (UK)

59175 AMORPHIZATION OF CRYSTALS BY ION BOMBARDMENT AND MECHANISMS OF SECONDARY PROCESSES. Sommerfeldt, H.; Mashkova, E. S.; Molchanov, V. A. (Moscow State Univ.). Radiat. Eff.; 9: No. 3-4, 267-71(Jun 1971). (In German).

Results of an experimental study of the ion−electron-emission coefficient of monocrystalline and amorphous germanium as a function of the angle of incidence for 10 to 30-keV Ne^+, Ar^+, Kr^+ ions are presented. Using the concept of ion channeling in crystals, the energy dependence of anisotropy of the ion−electron-emission coefficient is explained. (auth)

Physical Properties

59176 MAGNETIC PROPERTIES OF Sm–Gd ALLOYS. Shafigullina, G. A.; Chechernikov, V. I.; Torchinova, R. S. (Moscow Univ.). Fiz. Metal. Metalloved.; 31: No. 1, 217-19(Jan 1971). (In Russian).

Magnetic properties of alloys prepared from Sm and Gd were investigated in the temperature range 77 to 1100°K. The Sm-rich alloys possessed a low-temperature anomaly in magnetic susceptibility and, in the paramagnetic region, exhibited a complex temperature dependence of the susceptibility. The magnetic properties of the Gd-rich alloys resulted from a localization of the 4f electrons. (K.S.W.)

59177 THERMOEMISSIVE PROPERTIES OF A SPHERICAL MONOCRYSTAL OF TANTALUM. Azizov, U. V.; Karabaev, T. A.; Mukhailov, S. M. (Tashkent State Univ.). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 66-7(1971). (In Russian).

Emission patterns were prepared from a pure monocrystal of Ta and of the system $Ba-Ta_{hkl}$. The Ta had the same body centered cubic lattice as W, Mo, and Nb, and its emission pattern was also similar. Barium was sputtered onto a Ta surface and the work function of this system was investigated. (K.S.W.)

59178 X-RAY SPECTRA AND ENERGY BAND SCHEMES OF BeO AND BN. Fomichev, V. A. (Leningrad State Univ.). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 3, 754-6(Sep 1971).

Translated from Fiz. Tverd. Tela; 13: No. 3, 907-9(Mar 1971).

The x-ray emission and absorption spectra of the atomic components of BeO and BN were used to refine the electron band structure. The spectra were arranged so that they coincide at the Fermi level. For BeO, the widths of the forbidden and valence bands are 7.8 and 10.3 eV; for BN, they are 3.6 and 14.0 eV. The maxima of the valence bands are in good agreement with the most important peaks in the x-ray emission spectra of the components. (D.L.C.)

59179 TEMPERATURE DEPENDENCES OF THE DEBYE–WALLER FACTORS OF Zr, Nb, AND Mo. Korsunskii, M. I.; Genkin, Ya. E.; Vigdorchuk, L. I. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys -Solid State (Engl. Transl.); 13: No. 3, 761-2(Sep 1971).

Translated from Fiz. Tverd. Tela; 13: No. 3, 913-14(Mar 1971).

The reduced Debye−Waller factor M′ was measured at 90 to 400°K for reflections from the (123), (025), and (220) planes of $\alpha-$Zr, the (321) planes of Nb, and the (321) and (222) planes of Mo. The inequality $M'_{Zr} > M'_{Nb} > M'_{Mo}$ was found over the entire temperature range and was correlated with the melting point, strength of local orbitals, and shear moduli, but not with the sublimation heat. (D.L.C.)

59180 MAGNETIC SPECIFIC HEAT AND SPIN DISORDER RESISTIVITY OF URANIUM MONONITRIDE IN A 5 f^2 CONFIGURATION MODEL. de Novion, C. H. (CEN, Fontenay-aux-Roses, France). Compt. Rend., Ser. B; 273: No. 1, 26-9(5 Jul 1971). (In French).

The magnetic specific heat of UN is calculated in the molecular field approximation, assuming that the magnetic moments are those of a 5 f^2 configuration submitted to an octahedral crystal field. The effect of the crystal field on the spin-disorder resistivity is calculated for the paramagnetic state. (France)

59181 GADOLINIUM MAGNETIC EQUATION OF STATE NEAR THE CURIE POINT. Deschizeaux, M. N.; Develey, G. (Institue Polytechnique, Grenoble, France). J. Phys. (Paris); 32: No. 4, 319-23(Apr 1971). (In French).

From the magnetization field−temperature dependence of a gadolinium monocrystal near the Curie point, the critical exponents of the spontaneous magnetization, of the initial paramagnetic susceptibility, and of the critical isotherm is determined. An equation of state that defines the transition near T_c is given. (France)

59182 ELECTRIC PROPERTIES OF ALLOYS OF LANTHANUM HEXABORIDE WITH TRANSITION METALS. I. Bondarenko, V. P.; Kovenskaya, B. A.; Morozov, V. V. (Kiev Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 2, 12-15 (1970). (In Russian).

The effect of Hf, W, Ta, and Re additions on the electrical properties of lanthanum hexaboride was studied, and results are given of the measurement of electrical resistance, thermo-e.m.f., and Hall effect. The addition of 0.5 at.% Hf and W resulted in a sharp (up to 20 to 25%) decrease in the electrical resistance. It was found that the sudden reduction in resistance and thermo-e.m.f. was caused by redistribution of electron density and change in mobility on the formation of solid solutions. (D.H.M.)

59183 TEMPERATURE DEPENDENCE OF ELECTROPHYSICAL PROPERTIES OF ALLOYS OF LaB_6 WITH TRANSITION METALS. II. Bondarenko, V. P.; Kovenskaya, B. A. (Kiev Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 2, 90-3(1970). (In Russian).

The temperature dependence of electrical resistance is investigated in alloys of lanthanum hexaboride with additions (0.5, 1, 5, 10, and 15 at. %) of transition metals (Hf, Ta, W, Re). It is shown that the thermal coefficient of resistance of solid solutions of these metals with lanthanum hexaboride is determined by the properties of the dissolved metal, and on this basis the weakening of interatomic bonds in the series of solid solutions LaB_6 + 0.5% W, LaB_6 + 0.5% Re, LaB_6 + 0.5% Ta, and LaB_6 + 0.5% Hf is discussed. Data on the thermo-e.m.f. of these alloys are also given. (TSS)

59184 COMPARATIVE STUDY OF THE RELATION BETWEEN THE ELECTRIC CONDUCTIVITY AND GRAIN SIZE IN SINTERED URANIUM DIOXIDE. Rubio, Andre (CEN, Saclay, France). Compt. Rend., Ser. B; 272: No. 25, 1435-8(21 Jun 1971). (In French).

Room-temperature measurements of the electric conductivity of stoichiometric sintered UO_2 samples demonstrated that the electric resistivity varies as the reciprocal of the grain size. This result is associated with the UO_2 microstructure after sintering or heating under a strong temperature gradient. The grain growth occurring is associated with a decrease in porosity; density measurements demonstrated that the resistivity is an inverse function of the density. (France)

59185 EFFECT OF THORIUM ON Ce^{+3} PHOSPHORS. Hoffman, Mary V. (General Electric Co., Cleveland). J. Electrochem. Soc.; 118: No. 9, 1508-10(Sep 1971).

The effects of Th^{4+} on the Ce^{3+} and Tb^{3+} emission peaks in $CePO_4$ and $LaPO_4$ matrices were studied. The effects were found to be that of enhancement, and the composition effects of Th, Tb, and Ce were studied. The role of Th^{4+} in the enhancement of Ce^{3+} and Tb^{3+} emission in the monazite lattice is not energy transfer but valence control of the Ce ion (removal of Ce^{4+} ions). Decay and reflectance measurements which support this conclusion are reported. (D.L.C.)

59186 ELECTRICAL RESISTANCE AND STRUCTURE OF FILMS OF TUNGSTEN, MOLYBDENUM, AND CHROMIUM PRODUCED BY LASER EVAPORATION. Bondarenko, B. V.; Shchuka, A. A. (Moscow Physical-Technical Inst.). Fiz. Metal. Metalloved.; 30: No. 1, 207-10(Jul 1970). (In Russian).

Thin W, Mo, and Cr films were obtained by laser evaporation from the bulk metals and their electrical resistances were determined and correlated with film structure. Typical values of the specific electrical resistance of massive samples at 20°C were 4.9, 5.2, and 12.7 (in $10^{-6}\ \Omega \cdot cm$) for W, Mo, and Cr, respectively, whereas the corresponding values for the thin films were 360, 165, and 130. The temperature coefficient of resistance, however, was much smaller for the thin films than for the massive samples. (Metals Abstr.)

59187 OPTICAL PROPERTIES OF GADOLINIUM, SAMARIUM, AND DYSPROSIUM IN THE SPECTRAL RANGE 1.13 TO 3.96 eV. Knyazev, Yu. V.; Noskov, M. M. (Inst. of Metal Physics, Kiev). Fiz. Metal. Metalloved.; 30: No. 1, 214-17(Jul 1970). (In Russian).

The dispersion of the optical constants (refractive index n and absorption coefficient k) of Sm, Gd, and Dy was studied at 20°C for the spectral range 1.13 to 3.96 eV; the light conductivity $nk\nu$ (ν = frequency) was calculated from the results. Plotted against energy, the light conductivity exhibited a nonmonotonic character, indicating that this range of energies constituted a range of quantum transitions. The possible nature of these transitions is considered. (Metals Abstr.)

59188 INVESTIGATION OF TERNARY SOLID SOLUTIONS $Ni_3(Fe,V)$. Sarkisyan, R. S.; Selisskii, Ya. P.; Sorokin, M. N. Fiz. Metal. Metalloved.; 30: No. 1, 47-53(Jul 1970). (In Russian).

The temperature dependence of Young's modulus, the kinetics of the changes in electrical resistance during heat treatment, and the temperature dependence of electrical resistance were studied in ternary Fe–Ni–V solid solutions of the $Ni_3(Fe, V)$ type, and the results were correlated with x-ray analysis results. With increasing V content the Young's modulus, the order–disorder transformation temperature and the electrical resistance increased, while the saturation magnetization and Curie point diminished. On annealing the samples and cooling them slowly, there was an additional increase in Young's modulus not found in the quenched material. (Metals Abstr.)

59189 TEMPERATURE DEPENDENT ELECTROSTATIC INTERACTIONS BETWEEN MAGNETIC IONS IN URANIUM MONOPHOSPHIDE. Long, Christopher Eugene. Tallahassee; Florida State Univ. (1970). 92p. University Microfilms Order No. 71-18,371.

Thesis.

An experimental and theoretical investigation of the anomalous temperature variation of the magnetization of uranium monophosphide has been carried out. Neutron-diffraction measurements indicate that the sublattice magnetization undergoes a sharp change from 1.95 to 1.72 Bohr magnetons per ion upon warming to about 23°K. The procedure and results of ^{31}P nuclear magnetic resonance experiments are described. An unsuccessful attempt to explain the anomaly using a molecular-field theory including crystal-field effects is described, and the inability of this theory to explain the anomaly is proven. The importance of temperature-dependent electrostatic interactions between the charge distributions of the magnetic electrons associated with neighboring ions is examined, and it is shown that they may have an important influence on the magnetic properties of a large class of compounds. These interactions are crudely approximated in the theory by a temperature-dependent quadrupole–quadrupole interaction between the magnetic electron charge densities, and the modified theory is shown to be in excellent agreement with experiment in the temperature range of the anomaly. The modified theory fails to produce the observed temperature dependence of the magnetization near the Neel transition. The magnetic susceptibility is calculated and found to disagree with experiment. Several possible reasons for the disagreement are advanced, and suggestions for further experimental and theoretical work are given. (Diss. Abstr. Int., B)

59190 MAGNETIC TRANSITION POINTS IN U_3Bi_4 AND UGa_2. Sternberk, J.; Ansorge, V.; Hrebik, J.; Menovsky, A.; Smetana, Z. (Charles Univ., Prague). Czech. J. Phys.; 21: No. 9, 969-78(1971).

Polycrystalline compounds U_3Bi_4 and UGa_2 in powder form have been investigated by the method of H/M vs M^2 curves to find well-defined values of the magnetic transition temperatures T_C. For $T > T_C$ the asymptotic transition points have been obtained by linear extrapolation of the $1/\chi$ vs T dependence. It has been found that, in contrast to other papers, the points T_C and Θ_C coincide within the limits of experimental errors (±2°K). On the absolute scale these points are T_C = 112°K for U_3Bi_4 and T_C = 126°K for UGa_2. (auth)

59191 STUDY OF THE ELECTRICAL CONDUCTIVITY AND THERMOELECTRIC POWER OF URANIUM DIOXIDE UO_{2+x} AT HIGH TEMPERATURES. Sorriaux, Andrea; Djerassi, Henri (CEN, Saclay, France). Compt. Rend., Ser. B; 272: No. 24, 1373-6(14 Jun 1971). (In French).

Measurements effected on $UO_{2\overset{+}{x}}$ between 300 and 1100°K established that the conductivity is proportional to $T^{-3/4}e^{(-0.36/2kT)}$ in this range. It was possible to estimate the width of the forbidden band (approximately 1.8 eV) between 1100 and 1500°K. An investigation of the thermoelectric power, α, demonstrated that UO_{2+x} behaves as a p-type semiconductor, a change of sign occurring above 1430°K. The activation energy associated with α was evaluated to be 0.17 eV. (France)

59192 RESOLVED FINE STRUCTURE IN THE MAGNETIC RESONANCE OF A LOCALIZED MOMENT IN A METAL. Chock, E. P.; Chui, R.; Davidov, D.; (and others). (Univ. of California, Los Angeles). Phys. Rev. Lett.; 27: No. 9, 582-6(30 Aug 1971).

The first observation of the resolved fine-structure splitting of a localized moment in a metal is reported in the EPR spectrum of single-crystal dilute Au:Gd alloys. A theory of line narrowing of fine-structure lines from spin–spin couplings and localized-conduction electron exchange is developed. The narrowing distorts the observed resonance line shape and is essential to the

XUM

extraction of the fine-structure splitting parameter: $b_4 = -20 \pm 1$ G. (auth)

59193 ELECTRICAL PROPERTIES OF La_2O_3–CaO, Y_2O_3–CaO, AND ZrO_2–CaO SOLID ELECTROLYTES. **Etsell, Thomas Harvey.** **Toronto; Univ. of Toronto (1969). National Library of Canada, Ottawa.**

Thesis.

I. At 1600°C, La_2O_3 can dissolve about 16 mole % CaO which leads to the creation of anion vacancies. No compounds are formed in this system. The electrical conductivities of pellets containing from 0 to 50 mole % CaO were measured at 400 to 1100°C under oxygen pressures of 1 to 10^{-21} atm at 1000°C. The defect solid solutions behave as oxygen anion conductors below an oxygen pressure of 10^{-7} atm. The maximum ionic conductivity, which is 2.4×10^{-2} ohms^{-1} cm^{-1} at 1000°C, was observed at the solubility limit. At high oxygen pressures, the appearance of p-type conductivity, proportional to $P_{O_2}^{1/4}$, results in a region of mixed conduction. The apparent activation energies for both ionic and p-type conduction are ~17-20 kcal/mole. N-type conductivity was not observed at low oxygen pressures. Even La_2O_3 exhibits predominantly ionic conduction at intermediate oxygen pressures. Several transport numbers were verified by emf measurements. II. Only 5 to 8 mole % CaO could be dissolved in Y_2O_3 at 1600°C. The solid solutions are solely ionic conductors only below an oxygen pressure of about 10^{-12} atm. The ionic conductivities are almost two orders of magnitude lower than those exhibited by the La_2O_3–CaO electrolytes. Again, the p-type conductivity at high oxygen pressures varied as $P_{O_2}^{1/4}$. Since the apparent activation energies for ionic and p-type conduction are ~25-30 and 36 kcal/mole, respectively, ionic transport numbers decrease with increasing temperature. The ionic contribution to the conductivity of Y_2O_3 is very small. III. The behavior of impervious ZrO_2–10 mole % CaO electrolyte tubes was studied at 500 to 1100°C in oxygen concentration cells of the type (–) Ar–O_2 or CO–CO_2/ZrO_2–CaO/O_2 (+). The equilibrium oxygen pressures imposed by Ar–O_2 (1 to 10^{-6} atm) and CO–CO_2 (10^{-6} to 10^{-18} atm at 1000°C) mixtures were determined. When currents are passed through the oxygen concentration cell, only resistance polarization is generally observed in the presence of Ar–O_2 mixtures, even at current densities of 250 mA/cm^2 and 1000°C. If Ar–O_2 mixtures dilute in O_2 are present at the cathode, concentration polarization arises. Limiting currents, proportional to P_{O_2}, are controlled by the diffusion of oxygen through the gas phase to the reaction sites. When the oxygen pressure at the cathode is reduced to $10^{-27.5}$ atm at 1000°C, a significant amount of electronic conductivity is introduced into the electrolyte. For CO–CO_2 mixtures, activation polarization was detected. Exchange current densities are about 1 mA/cm^2 at 850 to 1100°C. The polarization behavior of the cell (–) Ar–O_2, $\underline{O}$(in Ag)/ZrO_2–CaO/O_2 (+) where $\underline{O}$ represents dissolved oxygen was investigated at 1000 to 1200°C. When voltages are applied to the cell to reduce oxygen in the liquid silver, limiting currents, controlled by the diffusion of oxygen in the melt, can be observed. The limiting currents are directly proportional to the concentration of dissolved oxygen (or $P_{O_2}^{1/2}$) from 0.01 to 2.0 at. % oxygen. This technique could be used to analyze liquid metals for dissolved oxygen. (D.L.C.)

59194 SURFACE ENERGY AND WORK FUNCTION OF THE SMOOTH FACES OF A METALLIC SINGLE CRYSTAL. **Zadumkin, S. N.; Shebzukhova, I. G.; Al'chagirov, B. B. Fiz. Metal. Metalloved.; 30: No. 6, 1313-15(Dec 1970). (In Russian).**

Controversial existing theories as to the relationship between the surface energy and work function of smooth faces on metallic single crystals are discussed, and a fresh attempt at solving the problem is presented. A simple expression relating the specific surface energy of smooth metal-crystal faces to their work function is derived and compared with experiment for Ni, Nb, Ta, Mo, and W. Theoretical and experimental data agree in order of magnitude, although there are still appreciable differences requiring further discussion. (Metals Abstr.)

59195 LOW-TEMPERATURE ELECTRICAL RESISTIVITY OF YCe UNDER PRESSURE. Maple, M. B.; Wittig, J. (Univ. of California, San Diego). Solid State Commun.; 9: No. 18, 1611-15 (15 Sep 1971).

The magnitude of the low-temperature electrical resistivity anomaly associated with the Kondo effect in Y–1 at.% Ce decreased with pressure and disappeared altogether above ~80 kbar, suggesting that the Ce impurities become nonmagnetic at high pressure. The depression of the superconducting transition temperature of Y by 1 at.% Ce at high pressure may be accounted for by scattering of conduction electrons into nonmagnetic Ce4f resonant states. (auth) (UK)

59196 MOLECULAR FIELD STUDY OF THE ISOTOPIC EFFECT IN $KH_{2x}D_{2(1-x)}PO_4$ MIXED CRYSTALS. Kopsky, V. (Inst. of Physics, Prague). Czech. J. Phys.; 21: No. 8, 896-916(1971).

The theory of KDP and isomorphous crystals is developed, which takes into consideration possible difference in ferroelectric interactions between pairs of H bonds with deuteration. It is shown why the interaction should differ from pairs of H–H, D–D, and H–D isotopes. Expressions for the transition temperature and static susceptibility above it are derived by approximating the molecular field acting on a proton (deuteron) by the field of the average surrounding. The theory results in a linear dependence of the asymptotical transition temperature and the Curie–Weiss constant on concentration. For the actual $T_c(x)$ also a linear dependence was found under the condition that tunneling is small, the distribution of H, D isotopes over H bonds is quite random, and that the interaction between isotopes is of purely dipolar character. Modifications of the linear dependence due to ordering and deviations of the interaction from dipolar are found. It is further suggested, as a result of comparison with recently performed measurements of pressure dependence of the transition point, that the main part of the isotopic shift of the transition point is due to the difference in H–H and D–D coupling, whereas the tunneling contributes by a relatively small amount. (auth)

59197 COBALT-RICH DUCTILE PERMANENT MAGNET ALLOYS WITH MOLYBDENUM ADDITIONS. **Steinitz, Robert (Wilbur B. Driver Co., Newark, N. J.). Met. Trans.; 2: No. 10, 2813-16(Oct 1971).**

The class of semihard permanent magnet compositions has been extended to compositions containing molybdenum. Under suitable conditions, these alloys can develop higher coercive forces (>100 Oe) and energy products (about 0.5×10^6) than could be obtained in similar materials before, but they can readily be worked to fine wires (5 mil or less). Coercive forces below the maximum can, of course, be arrived at by adjusting time and temperature of the aging treatment. Over 7% Mo was added to Co–Fe alloys; part of the molybdenum could be replaced by titanium. Cold work is necessary to develop precipitation within reasonable times. The new alloys are compared on the basis of their coercive force, residual magnetism, and squareness of the hysteresis curve. (auth)

59198 LOW-TEMPERATURE MAGNETIC BEHAVIOR OF SEVERAL OXIDES OF GADOLINIUM. **Miller, A. E.; Jelinek, F. J.; Gschneidner, K. A. Jr.; Gerstein, B. C. (Iowa State Univ., Ames). J. Chem. Phys.; 55: No. 6, 2647-8(15 Sep 1971).**

The low-temperature magnetic susceptibility, at 1 to 6°K, of the monoclinic and cubic, stoichiometric, and substoichiometric Gd_2O_3 phases are reported. The magnetic transformation temperatures were determined, and those of the substoichiometric phases probably give rise to the specific heat peaks observed in Gd metal containing appreciable amounts of oxygen. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 57887 and 59596.

59199 (NYO-2150-74) HINDERED ROTATION AT 2°K OF THE NO_2 IMPURITY IN KCl. **Bojko, Ignacy; Silsbee, R. H. (Cornell Univ., Ithaca, N. Y. Materials Science Center). Jun 1971. 40p. Dep. NTIS.**

The electron spin resonance of the NO_2 molecule incorporated as an impurity in KCl (produced by x irradiation of KNO_2 dopant) is studied in the temperature range 1.6 to 10°K and as a function of applied uniaxial stress at 1.8 and 4.2°K. The results are interpreted in terms of a model in which the molecule is assumed to be in uniaxial hindered rotation, with the first excitation energy, or tunneling splitting, estimated to be about 3 cm^{-1}, to be compared with a free rotational excitation energy of 8 cm^{-1}. Because the hindering potential is only moderate, it is necessary to include the effect of the molecular spin rotational coupling in developing a satisfactory spin hamiltonian to describe this system. (auth)

59200 ^{153}Eu INDIRECT SPIN–SPIN INTERACTION AND INHOMOGENEOUS LINE BROADENING IN FERROMAGNETIC EuO. **Barak, J.; Siegelstein, I.; Gabai, A.; Kaplan, N. (Hebrew Univ., Jerusalem). Phys. Rev. Lett.; 27: No. 12, 817-20(20 Sep 1971).**

The transverse relaxation rate of ^{153}Eu in EuO, caused by the indirect Suhl–Nakamura interaction, was calculated and measured. The results confirm the validity of a theoretical model developed recently to treat inhomogeneously broadened NMR lines. The local variation of the ^{153}Eu hyperfine field is determined and interpreted in terms of a local strain. (auth)

59201 ESR INVESTIGATION OF $3d^9$ IONS IN ALKALI HALIDES. Kuwabara, Goro (Tokyo Univ.). J. Phys. Soc. Jap.; 31: No. 4, 1074-84(Oct 1971).

Cu^{2+} in NaCl, LiCl, and NaF, and Ni^+ in NaCl, most of which were produced from Cu^+ and Ni^{2+} by x irradiation were studied by means of ESR. All of Cu^{2+} had elongated tetragonal surroundings, while Ni^+ had compressed ones. In $NaCl:Cu^{2+}$, the optical dichroism along a cube edge was detected at 5°K corresponding to the Jahn–Teller distortion. From the observed super hyperfine structure of surrounding nuclei, the amounts of covalency, f_s and f_σ were estimated as 0.77 to 0.89% and 7.9 to 12% in the chlorides, respectively. In the case of $NaCl:Cu^{2+}$ doped as divalent state, sharp anisotropic spectra outside the hyperfine structure due to Cu nucleus were observed, presumably due to coagulated ions. (auth)

59202 NUCLEAR SPIN RELAXATION STUDIES IN SOLID AND LIQUID DEUTERIUM. Wang, Richard Yuan-chang. Philadelphia; Univ. of Pennsylvania (1970). 211p. University Microfilms Order No. 71-19,296.

Thesis.

Pulsed NMR experiments in solid and liquid deuterium were performed over the temperature range 9 to 21°K. The spin–lattice relaxation times of a number of ortho–para compositions were measured as a function of temperature. The self-diffusion coefficients and activation energies were also reported. A kinetic model was proposed to account for the observations by making use of existing theories of spin–lattice and spin–spin relaxations. The dominated mechanisms for the relaxation of para-D_2 ($J = 1, I = 1$) and ortho-D_2 ($J = 0, I = 2, 0$) are (i) intramolecular interactions of $J = 1$ molecules (p-D_2) modulated by the anisotropic intermolecular quadrupolar interaction; (ii) intermolecular dipolar interaction which provides (a) a diffusion relaxation process, and (b) a cross relaxation process. The experiments and theory are in good agreement. (Diss. Abstr. Int., B)

59203 NEW MOESSBAUER ^{57}Co SOURCES. Godovikov, S. K.; Kuz'min, R. N. (Moscow State Univ.). Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 2, 220-1(Mar-Apr 1971). (In Russian).

Efforts to prepare a source containing ^{57}Co employed low-level (about 0.1 μ Ci/cm^2) mixtures containing a small amount of ^{57}Co in stable Co. The sources investigated were CoAl, CoBe, Co–25 at.% Cr, and Co–80 at.% Rh, and the pertinent parameters were measured as applicable to the Moessbauer effect. All alloys prepared were kept within the limits 20 to 30 mg, and the absence of an extraneous phase was confirmed with x-ray analysis. (K.S.W.)

Theory

59204 EXCITATIONS. Thouless, D. J. (Univ., of Birmingham, Eng.). pp 83-90 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

A model considered is based on the situation that exists when phonons in a solid or in liquid helium interact with one another. It displays many of the features that occur for excitations of electrons in a metal. (W.D.M.)

Theoretical Physics

Refer also to abstracts 58674, 58682, 59052, 59053, 59561, and 59612.

59205 (JINR–E2-6043) APPROXIMATE METHODS FOR SOLVING SCHROEDINGER EQUATION WITH MARGINALLY SINGULAR POTENTIAL. Filippov, A. T.; Gogokhiya, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 17p. Dep. NTIS (U. S. Sales Only).

The renormalization theory for the Schroedinger equation with marginally singular potentials is outlined. The singular potentials are shown to be classified naturally into renormalizable and nonrenormalizable ones by the structure of the perturbative series (with a small-distance cutoff) analogous to that of field theories. Approximate methods for solving the Schroedinger equation with the singular potential $g_0V(r)$ are discussed. These enable one to find the wave function as a series of powers of $g_0^\nu(\ln g_0)^n$, where n is an integer and ν is generally a noninteger (a modified perturbation theory). The most powerful method for constructing such a series is the "asymptotic" perturbation theory in which the first approximation for the wave function has the exact asymptotic behavior for $r = 0$. (auth)

59206 (LYCEN–7118) NON-EXHAUSTIVE RESTATEMENT OF THE ANGULAR MOMENTUM REDUCTION IN THE THREE-BODY PROBLEM. El Baz, E.; Fayard, C.; Lamot, G.-H.; Pigeon, J. (Lyon Univ. (France). Institut de Physique Nucleaire). Apr 1971. 26p. Dep. NTIS (U. S. Sales Only).

A brief description is given of the formalisms currently used for angular momentum reduction in the three-body problem. The Omnes symmetrical method is restated. Three unsymmetrical methods derived from Ahmadzadeh and Tjon's work are then presented. In the first one, due to Grubman, a particular determination of the body-fixed axis is used. The second method utilizes the expansion of a spherical harmonic, the argument of which is the sum of two vectors. The third method starts from the Faddeev–Lovelace formalism and also utilizes the expansion of a spherical harmonic. A comparison between these methods is made for the special case (n–d). (France)

59207 (NP–19033) ELEMENTARY SOLUTIONS OF THE SCHRODINGER EQUATION FOR SOME TIME DEPENDENT INTERACTIONS. Note No. 314. Pietronero, L.; Salusti, E. (Rome Univ. (Italy). Istituto di Fisica). 22 Apr 1971. 6p. Dep. NTIS (U. S. Sales Only).

Some simple cases of time-dependent Hamiltonians and their elementary solutions are described. (M.O.W.)

59208 EQUATION OF MOTION FOR THE P REPRESENTATION. Crosignani, B. (California Inst. of Tech., Pasadena); Ganiel, U.; Solimeno, S.; Di Porto, P. Phys. Rev., A; 4: No. 4, 1570-4(Oct 1971).

A new equation of motion, which describes the time evolution of the P representation in the Schroedinger picture, is derived. The equation applies to a very general class of Hamiltonians, and thus should be useful in many problems. As a demonstration of the usefulness of this equation, some known results are recovered by its direct application. (auth)

59209 METHODS AND PROBLEMS OF THEORETICAL PHYSICS. IN HONOUR OF R. E. PEIERLS. Conference Held at Birmingham, England, June 1967. Bowcock, J. E. (ed.). New York; American Elsevier Publishing Company, Inc. (1970). 450p. $21.75. (CONF-670675).

Eighteen of the twenty-five papers were considered in scope for NSA; four are abstracted separately and fourteen are listed by title. (W.D.M.)

For abstracts of individual papers see: 58448, 58804, 58918, 59204, 59323, 59324, 59437, 59530, 59613–59616, 59744, and 59847–59851.

59210 MOTION OF CHARGED PARTICLES IN APPROXIMATELY ORTHOGONAL ELECTRIC AND MAGNETIC FIELDS. Kuz'min, A. F. (Special Design Bureau of Analytical Instrument Design, Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 599-602(Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 765-9(Apr 1971).

The motion of charged particles in homogeneous electric and magnetic fields intersecting at an angle close to 90° is discussed for arbitrary orientation of the initial particle velocity. The parametric equations of the particle trajectory are obtained as a particular case of the particle trajectory in randomly intersecting electric and magnetic fields. Analytic expressions are derived for determining the particle coordinates at any instant of time as a function of the specific charge and initial velocity of the particle and the magnitude and angle of intersection of the fields. Approximate expressions are obtained which define the breakdown of the dividing and focusing properties of the fields for strictly mutual orthogonality. The fields most frequently used in a number of technical devices (multipliers, mass spectrometers, electronic instruments) are discussed. (auth)

59211 MODULATED RELATIVISTIC ELECTRON BEAMS. Korsunskii, A. M.; Repalov, N. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 648-50(Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 826-9(Apr 1971).

The development of oscillations is examined for a modulated slightly relativistic beam. The form and position of the resonance region are found. A variable modulation period is needed for full development of the instability. (auth)

59212 GENERALIZED WIDEROEE CONDITION AND ENERGY OF A PARTICLE IN AN AXIALLY SYMMETRIC TIME-VARYING MAGNETIC FIELD. Glikman, L. G. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 666-8(Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 843-7(Apr 1971).

It is shown that at certain times there is a simple connection be-

XUM

tween the magnetic flux through a circle with its center on the axis of symmetry and radius equal to the distance of the particle from this axis and the component of the magnetic field at the position of the particle parallel to the axis of symmetry. The energy of the particle at these times is estimated. The integral of the motion is found for certain time-varying fields. This quantity is then used to find the dimensions of the region occupied by the particle at any time, as well as the particle energy. (auth)

59213 EFFICIENT MONTE CARLO EVENT GENERATION METHOD FOR MULTIPERIPHERAL MODELS. **Friedman, Jerome H.; Lynch, Gerald R.; Risk, Clifford G.; Zang, Thomas A. Jr. (Univ. of California, Berkeley). J. Comput. Phys.; 8: No. 1, 144-52(Aug 1971).**

A Monte Carlo event generation method is presented that integrates multiperipheral models with good efficiency for all energies and all multiplicities up to 18. (auth)

59214 PROJECTIVE SOLUTION OF INTEGRAL EQUATIONS ARISING IN ELECTRIC AND MAGNETIC FIELD PROBLEMS. **Silvester, P.; Hsieh, M. S. (McGill Univ., Montreal). J. Comput. Phys.; 8: No. 1, 73-82(Aug 1971).**

Many integral equations arising in electric and magnetic field problems have Green's function kernels that cause difficulty in integration because of their essential singularities. By performing a simple coordinate rotation, these singularities can be shifted entirely onto one coordinate axis, so that iterated weighted numerical quadratures may be applied to evaluate exactly the projective representation of such integral operators on suitable finite-dimensional function spaces. Standard projective methods may therefore be applied to solve such integral equations accurately with very little computational effort. (auth)

59215 DERIVATION OF HYDRODYNAMICS FROM THE BOLTZMANN TRANSPORT EQUATION FOR QUASI-PARTICLES IN LIQUID ^{3}He AND FOR A PHONON GAS. **Tobenfeld, Emile Saul. Ithaca, N. Y.; Cornell Univ. (1971). 77p. University Microfilms Order No. 71-18,914.**

Thesis.

The problem of the derivation of hydrodynamics from the Boltzmann transport equation is considered for the case of quasi particles in liquid He^3 and for phonons in a solid at low temperature. It is shown that the use of the Chapman–Enskog method of developing hydrodynamics from the Boltzmann transport equation is justified for quasi particles in liquid He^3. The Navier–Stokes and Burnett equations are developed by this method. The coefficients are expressed in terms of certain integrals of the scattering cross section for single collisions. It is shown that the Chapman–Enskog method cannot be rigorously justified for the phonon gas. Conditions under which the Chapman–Enskog method would be expected to give a good approximation are developed. Numerical calculation is performed to determine whether these conditions hold for a simple model of the phonon gas. The Navier–Stokes and Burnett equations are developed in terms of the inverse collision operator for the phonon gas. Numerical calculations to determine whether the conditions for Chapman–Enskog theory hold and to calculate the coefficients of Navier–Stokes and Burnett equations are described, and progress on these calculations is reported. (Diss. Abstr. Int., B)

59216 SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS USING A SYMBOLIC STYLE OF ALGOL. **Roberts, K. V. (Culham Lab., Abingdon, Eng.); Boris, J. P. J. Comput. Phys.; 8: No. 1, 83-105(Aug 1971).**

A large class of physical problems reduces to the solution of nonlinear sets of partial differential equations. The success of mathematical physics in such problems depends closely on the available mathematical notation, which is both elegant and precise. Even so, certain information can only be obtained from numerical computations using finite-difference methods on discrete spatial and temporal grids. Existing computers are already powerful enough to handle many interesting problems in two and three dimensions, and the main limiting factor is now the time taken to develop the necessary programs. A symbolic style of writing Algol is developed using three-dimensional magnetohydrodynamics as an example. Programs written in this way are clear and concise and can be written and modified quickly with little chance for error; they can also be converted easily for use with any computer system. Thus the development of a working computational physics program need not take man-years of high-level scientific effort. The symbolic style of programming developed here overcomes the usual objections to large Fortran programs by introducing an operator formalism which is very close to the formalism developed for mathematical physics. One defines a set of difference operators which "look" and "feel" just like their differential counterparts and thus the details of the finite-difference scheme can be largely hidden from view. Although the Symbolic Algol "prototype" codes developed in this way execute too slowly for full three-dimensional production runs, the inner loops can readily be converted, either automatically or by hand, into highly optimized versions in any chosen language. (auth)

59217 UNIQUENESS OF THE POSITION OBSERVABLE IN AN IRREDUCIBLE UNITARY REPRESENTATION UP TO A FACTOR OF THE GALILEI GROUP. **Neumann, Holger (Univ., Marburg, Ger.). Ann. Phys. (Leipzig); 26: No. 2, 190-2(1971). (In German).**

An elementary quantum-mechanical system with nonvanishing mass is characterized by a continuous irreducible unitary representation up to a factor of the Galilei group in Hilbert space. An argument is given concerning the continuous irreducible unitary representations of the universal covering group of the Euclidean group such that the position observable is uniquely determined by the transformation properties under the representation of the Galilei group. (auth)

59218 RESOLUTION OF THE HIERARCHY OF GREEN'S FUNCTIONS FOR FERMIONS. **Fujita, Shigeji (State Univ. of New York, Buffalo). Phys. Rev., A; 4: No. 3, 1114-22(Sep 1971).**

The rigorous evolution equations for the one-body Green's functions ($g^>$, $g^<$) describing a system of interacting fermions are not closed (an analog of the Bogolyubov–Born–Green–Kirkwood–Yvon hierarchy for many-body distribution functions). The analysis of these equations is made in terms of proper connected diagrams. It is established that in the bulk limit, N (particle number) → ∞, Ω (volume) → ∞ while N/Ω remains finite, these equations can rigorously be transformed into closed equations with respect to ($g^>$, $g^<$). (auth)

59219 SUPPRESSION OF CHERENKOV RADIATION. **Prastein, S. Matthew (Argonne National Lab., Ill. Illinois Inst. of Tech., Chicago). Acta Phys. Austr.; 32: No. 1, 1-10(1970).**

The Fourier transform criterion for suppression of radiation is applied to the phenomenological treatment of Cherenkov radiation. It is shown that a large class of radiationless distributions may be described in terms of band-limited functions. (auth)

59220 NEW DERIVATION OF THE SECOND VIRIAL COEFFICIENT. **Servadio, Sergio (State Univ. of New York, Stony Brook). Phys. Rev., A; 4: No. 3, 1256-60(Sep 1971).**

A new, completely rigorous way of proving the relation between the second virial coefficient and the S matrix is presented. The method involves the use of the $U_{2,\infty}$ function introduced by Lee and Yang and proceeds in the most straightforward manner. Although difficulties are encountered for virial coefficients of higher order, there is hope that this type of approach might shed some light on the question of the connection between the virial series and the scattering matrix. (auth)

59221 SELF-INTERACTION AND ELECTROMAGNETIC RADIATION. **Goetz, Allan Charles. Washington, D. C.; George Washington Univ. (1971). 116p. University Microfilms Order No. 71-19,617.**

Thesis.

The present finite theories of electromagnetism are reviewed and their difficulties discussed. A new finite field theory of electromagnetism is proposed and is shown to produce results that agree with experiment. A self-interaction is found necessary to account for the incoherent radiation. The self-interaction chosen requires no renormalization and has the form originally suggested by Dirac. The structure of the Maxwell fields is analyzed using generalized function theory. The results are used to derive the synchrotron-radiation spectra for incoherent radiation and also to derive a new expression for the coherent-radiation spectra. These spectra are an accurate test of any theory of electromagnetism. Following the spirit of the classical theory, a semiclassical quantum theory of radiation is developed and the level shift of the 2s level of hydrogen is calculated without the need for renormalization. The electron is shown to contribute 429 MHz to this shift while the self-energy of the proton may well contribute the remaining 626 MHz. (Diss. Abstr. Int., B.)

59222 COMPLETE SETS OF DIAGONAL OPERATORS IN QUANTUM-STATISTICAL MECHANICS. **Caspers, W. J. (Technische Hogeschool Twente, Enschede, Netherlands); Van de Braak, H. P.; Verbeek, P. W.; Verstelle, J. C. Physica; 53: No. 2, 210-24(28 May 1971).**

Complete sets of diagonal operators, i.e., operators commuting with the Hamiltonian of a physical system, are constructed. In terms of these sets all diagonal operators can be written as a series, the uniform convergence of which is studied for infinitely large systems. This uniform convergence is introduced as a possible criterion for ergodicity. (auth)

59223 STATISTICAL MECHANICS OF AN ELECTRON GAS IN A MAGNETIC FIELD. Tsai, J. T. (State Univ. of New York, Buffalo); Wadati, M.; Isihara, A. Phys. Rev., A; 4: No. 3, 1219-38(Sep 1971).

The statistical mechanics of an interacting electron gas in a magnetic field is developed, based on a propagator method for weak fields and low temperatures. Detailed analytical considerations are given of the eigenvalues of relevant propagators, through which the grand partition function and the correlation energy are evaluated. The energy and the susceptibility are expressed in powers of r_s and the magnetic field. Corrections to the Landau susceptibility are obtained taking the finiteness of the density into consideration. In the absence of the magnetic field, the correlation energy reduces to the correct limit. The paramagnetic susceptibility and the polarization energy agree with what Brueckner and Sawada obtained by a different method in which a polarization parameter is assumed. An explicit expression for this parameter is also given. Thus, the evaluation of the correlation energy by Gell-Mann and Brueckner and that of the susceptibility by Brueckner and Sawada, Pines, and others are generalized. (auth)

59224 TRANSPORT EQUATIONS FOR DILUTE GASES WITH INTERNAL DEGREES OF FREEDOM. II. THE GENERALIZED MASTER EQUATION APPROACH. Tip, A. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica; 53: No. 2, 183-92(28 May 1971).

A transport equation for dilute gases with internal degrees of freedom, derived earlier from the BBGKY hierarchy, is obtained from the generalized master equation. It is demonstrated that the Zwanzig projection operator, used previously by various authors to derive the Waldmann–Snider equation, is not applicable in case generalizations of this equation are required. A different projection operator, which can be used under more general conditions, is discussed. (auth)

59225 NONLINEAR SCATTERING OF PARTIALLY COHERENT RADIATION BY FREE ELECTRONS. Chandra, Naresh; Goyal, Reva; Prakash, Hari (Univ. of Allahabad, India). J. Phys. Soc. Jap.; 31: No. 2, 326-30(Aug 1971).

The cross section for second-harmonic generation in Compton scattering is obtained, both quantum-mechanically and classically, for a radiation field of general nature in terms of fourth-order coherence functions. Strong dependence of this cross section on the nature of the incident radiation is shown by studying the special cases of coherent and chaotic beams of radiation having various polarizations and some cases of beams of radiation having stabilized amplitude. It is shown that the results reported in literature for this phenomenon hold only for coherent radiation and that those reported for unpolarized radiation are not correct. It is also shown that fourth-order coherence functions can be determined from the measurements of the intensity of the second-harmonic-scattered radiation in different directions, and the coherent states of radiation can be distinguished from the generalized coherent states. (auth)

59226 RADIATION OF SCALAR PARTICLES IN FIELD OF TWO TRAVELING ELECTROMAGNETIC WAVES MOVING TOWARD EACH OTHER. Bagrov, V. G.; Khalilov, V. R. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 1, 69-73(1969). (In Russian).

The radiation of a charged spinless particle in the field of two plane electromagnetic waves traveling toward each other, and possessing linear polarization, is considered in the approximation of small field potentials. Expressions for the radiation probabilties are obtained, and the polarization properties of the radiation are studied. (tr-auth)

59227 FORMAL EQUIVALENCE OF THE HYDROGEN ATOM AND HARMONIC OSCILLATOR AND FACTORIZATION OF THE BETHE–SALPETER EQUATIONS. Basu, Debabrata (Univ. of Delhi). J. Math. Phys. (N. Y.); 12: No. 8, 1474-82(Aug 1971).

The possible factorizations of the confluent hypergeometric equation are investigated and it is shown that this leads to a formal equivalence of the usual hydrogen–atom problem with that of a set of multidimensional harmonic oscillators of appropriate classical frequency in a space of varying (even) dimensionality ranging from $4l + 4$ to 2. This method is next used to investigate the solutions of some relativistic bound-state equations. As specific examples Goldstein's eigenvalue problem and the Wick–Cutkosky scalar meson equation are considered. A formal similarity also exists between the Goldstein problem and the scalar meson equation in the zero binding limit. The factorization of either of these equations leads to an infinite ladder of non-square integrable solutions. On the other hand, for arbitrary non-vanishing binding energies a complete solution of the scalar meson problem was obtained by investigating the zero-energy factorization of the equation. (auth)

59228 SCATTERING OF LIGHT BY A FLOW OF ELECTRONS THROUGH A CRYSTAL. Baryshevskii, V. G. (Belorussian State Univ., Minsk). Dokl. Akad. Nauk BSSR; 15: No. 4, 306-8(Apr 1971). (In Russian).

The scattering of photons of a laser wave by an electron beam as it passes through a crystal is investigated. If the wave length of the scattered photons is comparable to the interatomic distances, such photons undergo diffraction. This leads to a splitting of the frequencies of the scattered quanta, and, as a consequence of the effect of anomalous transmissions, to a decrease of the absorption of the photons in the medium. This anomalous transmission in the x-ray portion of the spectrum will occur in the bremsstrahlung radiation of charged particles passing through the crystal. (tr-auth)

59229 BRANDOW BOSON LINKED-CLUSTER EXPANSION APPLIED TO THE HIGH-DENSITY CHARGED BOSON GAS. Lee, J. C. (Northwestern State Univ., Natchitoches, La.). Phys. Rev., A; 4: No. 5, 2050-4(Nov 1971).

The Brandow boson linked-cluster expansion was used to redo the Foldy calculation of the Bogolyubov theory for a charged boson gas. The particle-number conservation is treated exactly. The ring diagrams were summed using the same techniques as used by Gell-Mann and Brueckner for the electron gas. The next-most-divergent diagrams (twisted rings) were also summed. These diagrams contain a renormalized hole line and thus show explicitly the dynamics of the condensate which is treated only in an average way in the Bogolyubov theory. The results for the ground-state energy and the condensation fraction agree exactly with Foldy in the high-density limit. (auth)

59230 EXACT RESULTS FOR A QUANTUM MANY-BODY PROBLEM IN ONE DIMENSION. Sutherland, Bill (Univ. of California, Berkeley). Phys. Rev., A; 4: No. 5, 2019-21(Nov 1971).

A system of either fermions or bosons interacting in one dimension is investigated by a two-body potential $V(r) = g/r^2$ with periodic boundary conditions. In addition to rederiving known results for correlation functions and thermodynamics in the thermodynamic limit, expressions are presented for the one-particle density matrix at zero temperature and particular (nontrivial) values of the coupling constant g, as a determinant of order $N \times N$. These concise expressions allow a discussion of the momentum distribution in the thermodynamic limit. In particular, for a case of repulsive bosons, the determinant is evaluated explicitly, exhibiting a weak (logarithmic) singularity at zero momentum, and vanishing outside of a "Fermi" surface. (auth)

59231 NUMERICAL ESTIMATE OF TRAJECTORIES OF CHARGED PARTICLES IN MAGNETIC AND VARIABLE-IN-TIME ELECTRIC FIELDS WITH DISCRETE POTENTIAL DISTRIBUTION. Grigorishin, I. L.; Belonuchkina, I. I. (Lab. of Electronics, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk; No. 1, 75-83(1969). (In Russian).

Such a distribution was obtained by computation of equations for the Dirichlet problem by the method of networks and by using grid electron integrators. On this basis, suggestions are made concerning the invariance of components of field strength in the elemental squares of network differences that permit integration of the equations of motion in each square. The cases of purely electric fields, crossed and combined, possessing the axial field symmetry, are examined. The influence of space charge is neglected. (tr-auth)

59232 COMPOSITE PARTICLES IN MANY-BODY SYSTEMS. Sakakura, Arthur Y. (Colorado School of Mines, Golden). Phys. Rev. Lett.; 27: No. 12, 822-6(20 Sep 1971).

Presented herein is a second-quantized formulation for a system of interacting nuclei and electrons expressed in terms of the creation and annihilation operators of various species of atoms and ions which can be formed by combining various numbers of the "elementary" particles. Processes such as ionization and recombination appear naturally. Explicit expressions for interatomic forces including exchange effects are generated from a "cluster expansion" reminiscent of the Ursell expansion. (auth)

59233 SINGULARITY STRUCTURE OF THE PERTURBATION SERIES FOR THE GROUND-STATE ENERGY OF A MANY-FER-

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MION SYSTEM. Baker, George A. Jr. (Brookhaven National Lab., Upton, N. Y.). Rev. Mod. Phys.; 43: No. 4, 479-531(Oct 1971).

Calculational procedures are developed for the ground-state energy of a many-fermion system. The entire theory is developed from the many-body Schroedinger equation via perturbation theory. The linked cluster expansion is derived by elementary methods. The analytic singularities of the energy function are analyzed, and procedures designed to avoid or overcome them. Results for the calculation of the energy in the presence of a purely repulsive two-body force are reviewed, and the situation is found to be reasonably satisfactory, though good results are restricted to wea potentials when the system is not dilute. Results for an attract potential surrounding a strongly repulsive core are reviewed, procedures described for calculations in this case. A sample c culation with an assessment of the probable errors is reviewed (auth)

59234 PHASE SPACE AND QUANTUM THEORY. Brittin, Wesley E. (Univ. of Colorado, Boulder). pp 47-91 of Topics in Modern Physics. /Brittin, Wesley E. (ed.). Boulder, Colo.; Colorado Associated Univ. Press (1971).

The problem of quantum mechanical representations in phase space is reviewed from a unified point of view. Particular attention is given to the use of localized states in phase space and their use in the representation theory. Their relation to coherent states is discussed as is their use in many-body theory. (W.D.M.)

59235 GROUP THEORY FOR PERMUTATION DEGENERACY IN FOUR ELECTRONS AND THE PAULI EXCLUSION PRINCIPLE. Van Vleck, J. H. (Harvard Univ., Cambridge, Mass.). pp 341-7 of Topics in Modern Physics. /Brittin, Wesley E. (ed.). Boulder, Colo.; Colorado Associated Univ. Press (1971).

The four-electron problem is treated as an explicit and instructive example, which is illuminating not just because it shows the restrictive role of the exclusion principle but also because it furnishes simple illustrations of many basic concepts of group theory such as homomorphy, isomorphy, etc., particularly as used to obtain representations and their characters. It is emphasized that the treatment is purely didactic, and does not pretend to give any basically new results. (W.D.M.)

59236 MARKOV APPROACH TO DENSITY FLUCTUATIONS DUE TO TRANSPORT AND SCATTERING. I. MATHEMATICAL FORMALISM. van Vliet, K. M. (Univ. of Montreal). J. Math. Phys. (N. Y.); 12: No. 9, 1981-98(Sep 1971).

A kinetic approach to fluctuations and correlations of stochastic processes depending on a continuous set of parameters y is presented. In particular, particle densities $n^p(y,t)$ which may refer to macroscopic densities in position space, or to microscopic quantities such as distributions in phase space, or occupancies of quantum states of which the labeling is continuous (as with Bloch states in solids) are considered. In a Markovian sense such processes are infinite dimensional. The fluctuating particle densities are considered in a Hilbert space: the analog of de Groot's a-space for nonspatial-dependent variables. Mainly, a Langevin description is used, i.e., one starts from presumed phenomenological equations, amended with source densities $\xi^p(y,t)$. A theorem is derived for the density–density or two-point covariance function (Λ theorem). In its general form, the theorem applies to the nonequilibrium steady state. It closely resembles the generalized g–r theorem for finite-dimensional processes. However, the solutions may involve extra parts stemming from stochastic boundary conditions and constraints. Simplifications for the thermal equilibrium case and the connection with generalized Onsager's relations are discussed. A variety of expressions for the spectral intensities $\Sigma^{pq}(y,y',\omega)$ are derived. In order to justify the Langevin procedure as well as to calculate the source terms and generalized Fokker–Planck moments, one considers the master-rate functional $W_{\gamma\gamma'}$ for transitions $\gamma \to \gamma'$ of the over-all state. Expressions are given for transitions involving change of species and scattering due to one- or two-body collisions. These determine uniquely the quantities entering into the Λ theorem. The statistical-mechanical basis for the formalism is discussed in some detail. (auth)

59237 MARKOV APPROACH TO DENSITY FLUCTUATIONS DUE TO TRANSPORT AND SCATTERING. II. APPLICATIONS. van Vliet, K. M. (Univ. of Montreal). J. Math. Phys. (N. Y.); 12: No. 9, 1998-2012(Sep 1971).

Applications of a macroscopic and microscopic nature are given of the Markov formalism, developed in the previous paper, for finding the pair-correlation function, two-point covariance function, and spectral intensities from the phenomenological transport equations, transitions, and scattering. As macroscopic examples, Rayleigh diffusion, Coulomb correlations, and space-charge-limited flow in solids are discussed. The diffusion equation is shown to be not strictly Markovian, though correct Langevin diffusion sources are easily found. Dielectric relaxation is shown to be a macroscopic manifestation of Coulomb correlations in a plasma. The Λ theorem of the previous paper yields for the pair-correlation functions the original Debye–Hückel result plus a δ term. The spectra for space-charge-limited flow due to single-carrier injection are treated with the Green's-function procedure. The discrepancies between existing theories are removed since the Coulomb correlations in the steady state are shown to be not of the Debye–Hückel type. As microscopic applications, we consider ideal gases in the presence of streaming due to fields, an extension of Lax's work. The connection with the BBGK two-point equations for one- and two-body collisions is established. Finally, one integrates over the stochastic Boltzmann equation to obtain stochastic hydrodynamic equations. These provide a microscopic basis for the noise sources associated with electrical conduction, heat conduction, and with the Navier–Stokes equation. Results for the hot-electron Boltzmann gas are compared with those of Price. (auth)

59238 ENSEMBLE VERSUS TIME AVERAGE PROBABILITIES IN RELATIVISTIC STATISTICAL MECHANICS. Landsberg, P. T.; Johns, K. A. (University Coll., Cardiff, Wales). Pure Appl. Chem.; 22: No. 3-4, 487-92(1970).

From International conference on thermodynamics; Cardiff, Wales (1 Apr 1970).

Reasons are advanced why discrete probabilities are not Lorentz-invariant. Such probabilities can be obtained as time average probabilities Π_i for state i in frame I. They can also be obtained from an ensemble E_1 of systems which, like the system of interest, are each on average at rest in a certain frame I_0. Such probabilities Q_i transform like the Π_i and ergodicity is then a Lorentz-invariant notion; If the ensemble is of the usual type (ensemble E_0) whose systems are all at rest in I_0, then the ensemble-based probabilities are Lorentz-invariant. If E_0 is used ergodicity is not a Lorentz-invariant notion; If entropy is regarded as invariant and entropy maximization is used, the canonical equilibrium probabilities Π_i which one finds contain an extra term which is not usually found. (auth) (UK)

59239 THEORY OF THE UNRESTRICTED HARTREE–FOCK EQUATION AND ITS SOLUTIONS. I. Fukutome, Hideo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 5, 1382-1406(May 1971).

A general theory of the unrestricted Hartree–Fock equation and its solutions is developed. Two different but, of course, equivalent nonconventional formulations of the Hartree–Fock equation are presented. The first formulation is derived from the equation of the density matrix. It is shown that the Hartree–Fock equation is equivalent to an intersection problem of certain quadratic hypersurfaces. The second formulation is derived from a parametric representation of the density matrix and the orbitals. The Hartree–Fock equation is converted to a coupled nonlinear equation for the parameter matrices. This form of the Hartree–Fock equation may be transformed into the form analogous to the Bogolyubov equation of superconductivity. Various representations of the Hartree–Fock energy are derived. A close correlation between the Hartree–Fock energy and the gaps of the orbital energies is indicated. An estimation for the upper and lower bounds of the number of different solutions of the Hartree–Fock equation is obtained. They are respectively $2^{(N^2-K)}$ and 2^K, where N is the dimension of the Hilbert space of the orbitals and K is the smaller number of n and N-n, n being the number of electrons in the system. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

59240 SEARCH FOR FRACTIONAL CHARGE USING LOW TEMPERATURE TECHNIQUES. Hebard, Arthur Foster. Stanford, Calif.; Stanford Univ. (1971). 150p. University Microfilms Order No. 71-19,698.

Thesis.

The purpose of the experiment described is to search for fractionally charged particles called quarks. The symmetries of high-energy physics would be greatly simplified if quarks with charge $\pm\frac{1}{3}$ and $\pm\frac{2}{3}$ the charge of an electron exist as the basic building blocks of all the known mesons and baryons. The proton, for example, would be made from two $+\frac{2}{3}$ quarks and one $-\frac{1}{3}$ quark. The central assumption of the experiment is that cosmic rays have been bombarding the earth since time began with sufficient energy to create free quarks which will combine with matter to form long-lived fractionally charged entities. A low-temperature apparatus is described which is capable of detecting electric charge smaller than that of an electron on a superconducting niobium sphere with a mass of 7×10^{-5} gm. A quark on the niobium sphere would be observable as an irreducible fractional charge and the probability of finding one is proportional to the mass of the sphere. For comparison, the mass of the niobium sphere is more than 10^6 times the mass of a typical Millikan oil drop. The sphere is suspended in a stable magnetic field between two parallel capacitor plates with an oscillation period of 1.5 seconds and a Q in the range of 1500-3000. A square-wave electric field is applied at the resonant frequency and the amplitude change, as recorded by a SQUID magnetometer, is a direct measure of the electric charge on the sphere. Separate positron (Na-22) and electron (Tl-204) radioactive sources are used for charge control. Preliminary results obtained for a single sphere indicate a nonzero residual charge of magnitude -0.37 ± 0.03. This value of approximate magnitude $-\frac{1}{3}$ does not necessarily imply the reality of quarks because of the fact that there might exist spurious charge forces which are caused by the apparatus. Such a force might arise for example if the induced electric dipole moment on the sphere, which is proportional to the electric field, interacts with a fixed field gradient, caused by a surface dipole layer on the capacitor plates, to give a force linear in the electric field and hence indistinguishable from the charge force. Before this result can be taken as evidence for a quark, the sensitivity of this apparent residual charge to different experimental conditions will be investigated and the results checked by measurements on other spheres which must have charge intercepts of only $-\frac{1}{3}$, $+\frac{1}{3}$ and zero. (Diss. Abstr.)

Electromagnetic

Refer also to abstract 59794.

59241 (CONF-710915-2) REVIEW OF EXPERIMENTS ON NUCLEON-NUCLEON BREMSSTRAHLUNG. Halbert, M. L. (Oak Ridge National Lab., Tenn.). [1971]. 24p. Dep. NTIS.

From Symposium on the two-body force in nuclei; Ann Arbor, Mich. (7 Sep 1971).

The review of nucleon–nucleon bremsstrahlung experiments includes proton–proton and neutron–proton bremsstrahlung. (J.F.P.)

59242 INELASTIC ELECTRON SCATTERING AT LARGE ANGLES. Miller, Guthrie. Stanford, Calif.; Stanford Univ. (1971). 147p. University Microfilms Order No. 71-19,727.

Thesis.

Electron-proton scattering cross sections were measured at electron scattering angles of 18, 26, and 34° for incident electron energies up to 18 GeV. These data extend in four momentum transfer squared (q^2) from 1 to 20 GeV^2 and in missing mass squared (W^2) up to 25 GeV^2. Using previously reported data at 6 and 10°, a separation of the two inelastic form factors was made in the deep inelastic region ($W^2 > 4$ GeV^2) for q^2 from 1.5 to 8 GeV^2. The transverse form factor is found to dominate in agreement with the expectations of various "parton" theories (for spin $\frac{1}{2}$ partons). Determination of the inelastic form factor W_2 allowed an investigation of the question of "scaling," i.e., that $\nu W_2 = F(\nu/q^2)$ in the deep inelastic large q^2 region. (Diss. Abstr.)

59243 PHOTOPRODUCTION OF π^0's FROM NEUTRONS AT 4 GeV. Bolon, G. C.; Bellenger, D.; Lobar, W.; (and others) (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev. Lett.; 27: No. 14, 964-6(4 Oct 1971).

The reaction $\gamma + n \rightarrow \pi^0 + n$ was measured at a photon energy of 4 GeV for $0.2 \leq -t \leq 1.8$ (GeV/c)^2. The cross section is slightly less than that with protons as a target. (auth)

59244 HEAVY LIQUID BUBBLE CHAMBER ANALYSIS OF η^0 NEUTRAL DECAY MODES: $\eta^0 \rightarrow 3\pi^0$ AND $\eta^0 \rightarrow \gamma\gamma$. Baglin, C. (Ecole Polytechnique, Paris); Bezaguet, A.; Degrange, B.; (and others). Nucl. Phys.; B22: No. 1, 66-84(1970).

The following decays of η^0 mesons produced in 350,000 photographs of a heavy liquid bubble chamber were observed: $\eta^0 \rightarrow \pi^+\pi^-\pi^0$, $\eta^0 \rightarrow 3\pi^0 \rightarrow 6\gamma$, $\eta^0 \rightarrow \gamma\gamma$. All the γ-rays coming from these decays were observed and measured; this provides a direct separation of the two neutral modes and independent measurements of the two following branching ratios: $R_1 = \Gamma(\eta^0 \rightarrow 3\pi^0)/\Gamma(\eta^0 \rightarrow \pi^+\pi^-\pi^0)$ and $R_2 = \Gamma(\eta^0 \rightarrow \gamma\gamma)/\Gamma(\eta^0 \rightarrow \pi^+\pi^-\pi^0)$. This analysis was done with 526 $\eta^0 \rightarrow \pi^+\pi^-\pi^0(\pi^0 \rightarrow \gamma\gamma)$, 199 $\eta^0 \rightarrow 3\pi^0 \rightarrow 6\gamma$ and 401 $\eta^0 \rightarrow \gamma\gamma$ events. The result $R_1 = 1.50^{+0.15}_{-0.29}$ is in agreement with the theoretical predictions assuming that $\eta^0 \rightarrow 3\pi$ decays are pure $\Delta I = 1$ transitions. The result $R_2 = 1.72 \pm 0.25$, combined with R_1 and compared with the present world average of the ratio $\Gamma(\eta^0 \rightarrow$ neutrals$)/\Gamma(\eta^0 \rightarrow \pi^+\pi^-\pi^0)$, is compatible with the absence of the mode $\eta^0 \rightarrow \pi^0\gamma\gamma$ or with only a small decay rate for this last mode. The $\eta^0 \rightarrow 3\pi^0$ Dalitz plot was studied, the three π^0 being reconstructed from the measurements of the 6γ-rays, using kinematical fits. No significant variation of the $\eta^0 \rightarrow 3\pi^0$ amplitude was found. The coefficient of the term quadratic in pion energies in this amplitude is found to be $\alpha = -0.32 \pm 0.37$. (auth)

59245 CALCULATED COSMIC-RAY MUON SPECTRA AT HIGH ENERGIES (>20 GeV). O'Brien, Keran (Atomic Energy Commission, New York). Phys. Rev., D; 4: No. 3, 635-8(1 Aug 1971).

Calculations of sea-level cosmic-ray muon spectra were made at 75°, 80°, 85°, and 88.75° between 20 and 1000 GeV, and compared with measurements made at Argonne National Laboratory. Although the experimental results are a consistent 60% of the calculated values, leading to too few muons being found at high zenith angles, it is felt that this does not support the Utah anomaly, as the discrepancy is energy- and angle-independent. Similarly, no exotic processes, such as the failure of special relativity, seem to be operating. (auth)

59246 ELECTROMAGNETIC INTERACTIONS OF HIGH-ENERGY COSMIC-RAY MUONS. Allkofer, O. C.; Grupen, C.; Stamm, W. (Univ., Kiel). Phys. Rev., D; 4: No. 3, 638-46 (1 Aug 1971).

The electromagnetic interactions of cosmic-ray muons in the energy range up to 1 TeV were investigated with a spark-chamber calorimeter in combination with the Kiel spectrograph. The purpose was to investigate the different kinds of electromagnetic processes (knock-on, direct-pair, bremsstrahlung, and multiple pion production) in the range of energy transfer from 0.2 to 100 GeV. The production of pions is in reasonable agreement with the theoretical prediction of Daiyasu et al. In the region of high energy transfer (>2 GeV) with experimental results agree with Bhabha's theory of the knock-on process as well as with Murota's theory of direct pair production. However, in the region of energy transfer around 1 GeV there are minor deviations from these theories, in contradiction with accelerator data. (auth)

59247 PHENOMENOLOGY OF MUON SHOWERS UNDERGROUND. Davis, K. H.; Fall, S. M.; Ingebretsen, R. B.; Stenerson, R. O. (Univ. of Utah, Salt Lake City). Phys. Rev., D; 4: No. 3, 607-26(1 Aug 1971).

Measurements of shower arrival directions (incident in a range of zenith angles between 40° and 70° and slant depth of rock between 2×10^5 and 6.5×10^5 g cm^{-2}), structure, and intensities are used as the basis to develop a detailed descriptive phenomenology of muon showers underground. Distributions in right ascension and declination corresponding to minimum values of the median primary energy ranging from 25 TeV for single detected muons to 9000 TeV for events where six muons were detected revealed no compelling evidence for anisotropy in the primary radiation. Measurements of counting rates of groups of two and three of the nearly parallel muons in individual showers as a function of muon separation (structure) were found to be consistent with a shower radial density distribution having the form $\rho(r) = P(r/\sigma) \times \exp(-r/\sigma)$, where r is the distance of the shower axis in m, P is a polynomial in (r/σ), $\sigma = K \times (\sec\theta)^{1.3}/E_\mu^{0.8}$, θ is the zenith angle in degrees, E_μ is the threshold muon energy in units of TeV, and $K = 3.6$ m. The empirical shower radial density distribution above reduces to one predicted by Adcock, Wdowczyk, and Wolfendale on the basis of a detailed shower development calculation with a value of $K = 4$

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m at an energy of 1 TeV and a zenith angle of 45°. Assuming that the distribution of shower sizes is proportional to a power law in shower size, the exponent of the shower-size distribution was measured and found to lie in the range −3.5 to −4.5. The parameters of an empirical density spectrum were optimized by iterative fits to the numbers of events where one to three muons were detected with the result that best-fit parameters were close to those previously obtained by Porter and Stenerson using a smaller sample of shower data. The predicted energy and angular dependence is shown to be in reasonable qualitative agreement with intensities measured in 20-m^2 detectors. (auth)

59248 CHARGED π-MESON PHOTOPRODUCTION ON NUCLEI AT $E_0 = 560$ MeV. Grishaev, I. A.; Krinitsyn, A. N.; Lapin, N. I.; (and others) (Physical-Technical Inst., Kazan). Yadern. Fiz.; 14: No. 1, 35-9(Jul 1971). (In Russian).

Yields of charged pions on C, Al, Cu, and Pb nuclei are measured at the maximal energy of the bremsstrahlung γ quanta $E_0 = 560$ MeV. The measurements are performed on the electron linear accelerator at the Physico-Technical Institute of the Ukranian Academy of Sciences. The π^+ and π^- mesons with kinetic energies 40 and 65 MeV were registered using photoemulsions under 60 and 120° angles. The dependence of the total yield on the atomic weight is given. The experimental data are discussed in framework of the optical model. (auth)

59249 COMPLEX INVESTIGATION OF EXTENSIVE AIR-SHOWER CORE WITH ENERGY $\geq 10^{15}$ eV. Cherdyntsev, K. V.; Rakobol'skaya, I. V.; Nikol'skii, S. I.; Varkovitskaya, A. Ya. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 14: No. 2, 371-7(Aug 1971). (In Russian).

An event of penetration of an extensive air-shower core with energy $\geq 10^{15}$ eV through the Tien Shan complex plant is discussed. A conclusion is presented on the multi-core character of the shower that is due to large transversal momenta. A change of inelastic interaction process with high energy transfer to the electron−photon component is noted. (auth)

59250 HIGH-ENERGY ELECTRON−POSITRON ELASTIC SCATTERING. Bartoli, B. (CNEN, Frascati, Italy); Felicetti, F.; Ogren, H.; (and others). Phys. Lett.; 36B: No. 6, 593-7 (18 Oct 1971).

The analysis of 5164 wide angle Bhabha events collected at several c.m. energies between 1.4 and 2.4 GeV using the Frascati e^+-e^- storage ring, ADONE, is presented. The results are in agreement with the predictions of quantum electrodynamics within the experimental errors (±10%). (auth)

59251 MULTIPARTICLE PRODUCTION FROM e^+e^- INTERACTIONS AT HIGH ENERGY. Bartoli, B. (CNEN, Frascati, Italy); Felicetti, F.; Ogren, H.; (and others). Phys. Lett.; 36B: No. 6, 598-602(18 Oct 1971).

Measurements of multiple particle production at ADONE, the Frascati e^+e^- storage ring, were carried out at c.m. energies 1.4 GeV to 2.4 GeV. The hadronic nature of the observed particles is discussed and a lower limit of 30 nbarn set for the total multiparticle cross section. (auth)

59252 DETERMINATION OF THE REAL PART OF THE ρ-NUCLEON FORWARD SCATTERING AMPLITUDE AND THE RELATIVE $\rho-\omega$ PRODUCTION PHASE. Biggs, P. J.; Braben, D. W.; Clifft, R. W.; Gabathuler, E.; Rand, R. E. (Daresbury Nuclear Physics Lab., Warrington, Eng.). Phys. Rev. Lett.; 27: No. 17, 1157-60(25 Oct 1971).

The real part of the ρ−nucleon forward scattering amplitude was obtained by a measurement of the photoproduction of asymmetric electron−positron pairs from a carbon target. A determination of the relative $\rho-\omega$ production phase is also made. At a mean incident photon energy of 4 GeV the ratio of the real to the imaginary part of the ρ−nucleon amplitude is found to be -0.28 ± 0.12. (auth)

59253 STUDY OF THE VERTICES $\pi^0\gamma\gamma$, $\eta\gamma\gamma$, AND $\eta'\gamma\gamma$ WITH ALMOST REAL PHOTONS. Parisi, J. (Univ., Paris); Kessler, P. Lett. Nuovo Cim.; No. 15, 755-9(9 Oct 1971).

It is suggested that the vertices $\pi^0\gamma\gamma$, $\eta\gamma\gamma$, and $\eta'\gamma\gamma$ can be studied experimentally from processes of the type $e^-e^+ \to e^-e^+X \to e^-e^+\gamma\gamma$ ($X = \pi^0$, η, or η'). The outgoing electron and positron are detected at very small angles with respect to their incident directions, in coincidence with the two photons produced at large angles with respect to the beam axis. It is shown that the cross sections predicted are high enough to ensure reasonably large counting rates with future electron-positron storage rings of energy ~1 to 3 GeV and luminosity $\sim 10^{32}$ cm^{-2} s^{-1}. (L.B.S.)

Weak

59254 (BNL-tr-449) SEARCH FOR THE DECAY $\mu^+ \to e^+ + e^+ + e^-$. Korenchenko, S. M.; Kostin, B. F.; Nekrasov, G. K.; Mitsel'makher, G. V.; Smirnov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P1-5542. 4p. Dep. NTIS.

A cylindrical spark chamber was used to search for the decay $\mu^+ \to e^+ + e^+ + e^-$. It was established that the upper limit for the branching ratio for this decay is $6.2(10)^{-2}$, which is about 20 times less than that determined earlier. (J.F.P.)

59255 (BNL-tr-451) SEARCH FOR THE $\pi^+ \to e^+ + \nu_e + e^+ + e^-$ DECAY. Korenchenko, S. M.; Kostin, B. F.; Mitsel'makher, G. V.; Nekrasov, K. G.; Smirnov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from report JINR-P1-5250. 5p. Dep. NTIS.

A spark chamber was used to search for the decay $\pi^+ \to e^+ + \nu + e^+ + e^-$. An upper limit for the branching ratio of this decay was found. (J.F.P.)

59256 BRANCHING RATIO $K \to e\nu/K \to \mu\nu$: A TEST OF V−A THEORY OF WEAK INTERACTIONS. McReynolds, John Frederick. Berkeley, Calif.; Univ. of California (1970). 91p. University Microfilms Order No. 71-20,854.

Thesis.

An optical spark chamber experiment utilizing an axially focusing cylindrically symmetric spectrometer has gathered 62.6 ± 11 $K \to e\nu$ events, giving a branching ratio Ke_2 $K\mu_2 = 2.32 \pm 0.39 \times 10^{-5}$, and setting new limits of $0 \leq |(f_P/f_A)| < 1.75 \times 10^{-4}$ or $1.82 \times 10^{-3} < |(f_P/f_A)| < 2.12 \times 10^{-3}$. A beam of 500 K^+/pulse with $K^+/\pi^+ = 0.002$ from the Bevatron external proton beam was stopped on the spectrometer axis. Charged particles over 0.4 or 4π were allowed a single orbit in the spectrometer. Such particles in a 12% momentum bite passed through a 300-psi ethane Cherenkov counter, a scintillator and spark chamber array designed for ±1% momentum analysis, and into a lead cylinder, spark chamber, and scintillator array designed for muon rejection. Events were scanned and measured on SASS, an automatic scanning system. A total of 150,000 events were measured, analyzed, and kinematically reconstructed. These events satisfied trigger requirements for Ke_2, for K → charged particle + γ, and for normalization to $K\mu_2$, $K\pi_2$, and Ke_3. (Diss. Abstr.)

59257 MASS OF MUON NEUTRINOS. Gabos, Zoltan; Demsoreanu, Brutus. Stud. Univ. Babes-Bolyai, Ser. Phys.; 16: No. 1, 21-4(1971). (In German).

The possibility of determining the mass of the muonic neutrino from measurement of the longitudinal polarization of the muon in $\pi^- \to \mu^- + \bar{\nu}_\mu$ decay is examined. (L.B.S.)

59258 EXPERIMENTAL STUDY OF THE DALITZ PLOT IN THE DECAY $K_L^0 \to \pi^+ + \pi^- + \pi^0$. Takats, Martha Carroll. Philadelphia; Univ. of Pennsylvania (1970). 132p. University Microfilms Order No. 71-19,290.

Thesis.

In a study of 6270 $K_L^0 \to \pi^+ + \pi^- + \pi^0$ decays, the Dalitz coordinates $X = 3(T_+-T_-)/Q$ and $Y = (3T_0-Q)/Q$ were measured, in an attempt to test the $\Delta I = 1/2$ rule and CP-conversion in the decay. The experiment was performed in the 49° neutral beam at the Princeton-Pennsylvania Accelerator. The tracks of the charged pions were recorded by means of wire spark chambers and their momenta determined by means of a large-aperture magnet with field of about 4000 gauss. Time-of-flight measurements were used to separate out leptonic decays and to resolve the kinematic ambiguity in the reconstruction of kaon momentum. In previous experiments, reconstruction of the quantity $P_0'^2$, the kaon momentum in the frame in which the momentum of the charged-pion pair is purely transverse, has permitted fairly good separation of leptonic and $K \to 3\pi$ decays, by the requirement that $P_0'^2$ be positive. The usual cut on $P_0'^2$ was not used, but many events with $P_0'^2 < 0$ could not be reconstructed on the Dalitz plot. A Monte-Carlo calculation was performed to correct the data for detection efficiencies and extract the spectrum on the Dalitz plot, and to check the detection efficiency for leptonic decays. On the basis of the calculations, it was estimated that the leptonic background is less than 5%, and that the reconstructed leptonic decays populate the Dalitz plot uniformly. The spectrum was extracted in two ways: by binning events in X and Y, and by transforming the Dalitz plot to the unit circle and using the method of orthogonal functions. The results for fitting the data to a quadratic spectrum $F(X,Y) = 1 + aY + bY^2 + cX^2 + dX$ were identical in the two methods. If $\Delta I = 1/2$, these coefficients may be simply related to the coefficients for τ^+ and $\tau^{+\prime}$ decays. The coefficient a = -0.563 ± 0.026, when compared to the results for τ^+ decay, is consistent with the $\Delta I = 1/2$ rule, but large quadratic coefficients were found which appear to violate $\Delta I = 1/2$. The fit to a quadratic spectrum was very poor ($P < 0.0001$). Certain bins were found to be sensitive to differences between Monte-Carlo calculations and data with respect to the number of events with $P_0'^2 < 0$. When these bins were omitted, a much better fit was obtained ($P \sim 0.1$). In the new fit, a = -0.771 ± 0.040, in violation of $\Delta I = 1/2$. The slope σ_0, which is proportional to the coefficient a, has been measured in four previous experiments, with a total of about 10,000 events. Two of the reported values are consistent with $\Delta I = 1/2$; two are not. The results differ by more than five standard deviations. It is believed that sensitivity to the $P_0'^2$ cut has resulted in the disagreement among the quoted slopes. The coefficient d measures the interference term between I = 1 and CP-violating I = 2 states. It is found that d = 0.011 ± 0.032 is consistent with CP conservation in the decay. (Diss. Abstr.)

59259 SEARCH FOR THE DECAY OF THE SHORT-LIVED NEUTRAL K MESON INTO TWO CHARGED PI MESONS AND ONE NEUTRAL PI MESON. **Jones IV, Lewis Hammond.** Urbana, Ill.; Univ. of Illinois (1971). 148p. University Microfilms Order No. 71-21,148.

Thesis.

A spark chamber experiment was run at Argonne National Laboratory to search for the decay $K_S^0 \to \pi^+\pi^-\pi^0$. CP does not forbid this decay, but the CP-conserving states are strongly suppressed by centrifugal barriers. Therefore, observation of a large amplitude for $K_S^0 \to \pi^+\pi^-\pi^0$ would indicate probably CP violation in this decay mode. The method used was to measure the time distribution of $K^0 \to \pi^+\pi^-\pi^0$ decays in the region from 0.5 to 6.5 K_S^0 lifetimes. The K^0 mesons were produced in a 3 cm long carbon target via the reaction $\pi^-p \to K^0\Lambda$ at a beam momentum of 3 GeV/c. Identification of the Λ insured that there was no $\overline{K}^0$ contamination in the data at t = 0. The momenta of the charged decay products were measured using thin foil spark chambers placed in a 10 kG magnetic field. Photons from π^0 decay were identified by observation of showers in heavy plate spark chambers. Two charged particle tracks and one photon track, consistent with $K_{\pi 3}^0$ decay, were required. The time distribution for the 99 events in the final sample was fit by the method of maximum likelihood for the complex amplitude ratio $x + iy = [(K_S^0 \to \pi^+\pi^-\pi^-)/(K_L^0 \to \pi^+\pi^-\pi^0)]$. The result is $x = -0.09 \pm 0.19$, $y = 0.56 \pm 0.43$. This result indicates a possible violation of CP in $K_{\pi 3}^0$ decays but is also consistent with CP conservation at the one-standard deviation level. The value of χ^2 for x = y = 0 is 6.10 for four degrees of freedom with χ^2 probability = 19.2%. A second result found in the likelihood fit is statistically preferred over the first result but is ruled out on theoretical and experimental grounds. (Diss. Abstr.)

59260 PRECISION MEASUREMENT OF THE LIFETIME AND DECAY BRANCHING RATIO OF THE Λ^0 HYPERON. Baltay, C. (Columbia Univ., New York. Brookhaven National Lab., Upton, N. Y.); Bridgewater, A.; Copper, W. A.; Habibi, M.; Yeh, N. Phys. Rev., D; 4: No. 3, 670-6(1 Aug 1971).

A precision measurement of the Λ^0 lifetime τ_Λ and the branching ratio $R = (\Lambda \to p\pi^-)/(\Lambda \to \text{all})$ was carried out. The results are $\tau_\Lambda = (2.54 \pm 0.04) \times 10^{-10}$ sec and $R = 0.646 \pm 0.008$. The errors include both the statistical errors and our estimate of the systematic errors. (auth)

59261 STRANGENESS-CHANGING LEPTONIC DECAY RATES FROM THE $\Sigma^\pm$ HYPERONS. Cole, J. (State Univ. of New York, Stony Brook); Lee-Franzini, J.; Loveless, R. J.; (and others). Phys. Rev., D; 4: No. 3, 631-5(1 Aug 1971).

The strangeness-changing leptonic branching ratios of the $\Sigma^\pm$ hyperon were determined from a stopping K^- exposure in the BNL-Columbia 30-in. hydrogen bubble chamber. The ratio $(\Sigma^- \to ne\nu)/(\text{all } \Sigma^- \text{ decays})$ is $(0.97 \pm 0.15) \times 10^{-3}$, and the ratio $(\Sigma^- \to n\mu\nu)/(\text{all } \Sigma^- \text{ decays})$ is $(0.38 \pm 0.11) \times 10^{-3}$. No evidence is found for $\Delta S = \Delta Q$ violations, and an upper limit for the ratio of decay rates $[(\Sigma^+ \to ne\nu)/(\Sigma^- \to ne\nu)]$ is determined to be <12.6% with 95% confidence. (auth)

59262 MEASUREMENT OF K_{e4}^+-DECAY RATES AND TEST OF THE $\Delta S = \Delta Q$ RULE. Bourquin, M. (Univ., Geneva); Boymond, J. P.; Extermann, P.; (and others). Phys. Lett.; 36B: No. 6, 615-18(18 Oct 1971).

In a study of 1609 K_{e4} decays observed at the CERN PS, the rate of $K^+ \to \pi^+\pi^-e^+\nu$ was found to be $(3.32 \pm 0.31) \times 10^3$ sec^{-1}. An upper limit of 43 sec^{-1} at the 95% confidence level was obtained for the $\Delta S = \Delta Q$ violating mode $K^+ \to \pi^+\pi^+e^-\overline{\nu}$. (auth)

59263 DETERMINATION OF THE LOW-ENERGY $\pi-\pi$ PHASE SHIFTS AND FORM FACTORS IN K_{e4}^+ DECAY. Basile, P. (CEN, Saclay, France); Brehin, S.; Diamant-Berger, A.; (and others). Phys. Lett.; 36B: No. 6, 619-22(18 Oct 1971).

In a study of 1609 K_{e4}^+ decays observed at the CERN PS a single solution for the form factors and the $\pi-\pi$ phase-shift difference $\Delta = \delta_s^0 - \delta_p^1$ averaged over the invariant dipion mass ($m_{\pi\pi} = 313$ MeV) was calculated. $\Delta = 0.37 \pm 0.07$ was found. (auth)

59264 MEASUREMENT OF THE $K_L^0 \to 2\gamma$ BRANCHING RATIO AND SEARCH FOR $K_S^0 \to 2\gamma$ DECAYS. Repellin, J.-P. (Laboratoire de l'Accelerateur Lineaire, Orsay, France); Wolff, B.; Chollet, J. C.; (and others). Phys. Lett.; 36B: No. 6, 603-6 (18 Oct 1971).

Using an optical spark chamber set-up, the two photon decay rate of neutral K mesons behind a regenerator was measured. $K_L^0 \to 2\gamma$ decays are normalized to $K_S^0 \to 2\pi^0$ events, so the result depends on the K^0 regeneration in copper at 2 GeV/c and has a value of $\Gamma(K_L^0 \to 2\gamma)/\Gamma(K_L^0 \to \text{all}) = (5.0 \pm 1.0) \times 10^{-4}\ [22\text{ mb}/(|f - \overline{f}|/k)]^2$. $K_S^0 \to 2\gamma$ events are not observed, and from the normalization to $K_S^0 \to 2\gamma^0$, $\Gamma(K_S^0 \to 2\gamma)/\Gamma(K_S^0 \to \text{all}) < 1.2 \times 10^{-3}$ was obtained with 90% confidence. (auth)

Strong (Baryon-Induced)

Refer also to abstract 59696.

59265 (JINR-P2-5991) INTRANUCLEAR CASCADES IN LIGHT NUCLEI. Abdinov, O. B.; Barashenkov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 13p. (In Russian). Dep. NTIS (U. S. Sales Only).

A model of intranuclear cascades, allowing for a density change in the target nucleus proportional to the cascade development, is applied to light hydrogen-type nuclei. In the energy range $T \leq 1$ GeV the effect of the density change affects the properties of the cascading particles comparatively weakly (the number of low-energy particles decreasing somewhat), but substantially influences the yield of various isotopes at energies $T \cong 300$ to 400 MeV. The calculation of cluster structure of target nuclei noticeably affects the yield of isotopes. (tr-auth)

59266 (SJC-P-71-1) ANTIPROTON-PROTON CHARGE EXCHANGE AND ELASTIC SCATTERING AT 232 MeV. Hirose, T.; Yamagata, Fukawa, M.; (and others) (Tokyo Univ. (Japan). Inst. for Nuclear Study). Apr 1971. 14p. Dep. NTIS (U. S. Sales Only).

Angular distributions of charge exchange scattering ($\bar{p}p \to \bar{n}n$) and elastic scattering ($\bar{p}p \to \bar{p}p$) were measured at energy of 232 MeV. Pictures used were obtained by exposure with an 80-cm Saclay chamber. In order to identify the reaction $\bar{p}p \to \bar{n}n$, emitted $\bar{n}$s were observed inside the fiducial volume as characteristic annihilation stars with odd number of prongs and positive net charge. For $\bar{p}p \to \bar{n}n$, 42018 pictures were scanned twice for 3.5 and 7 prong stars associating with 0 prongs, and 282 events were obtained. Number of events of $\bar{p}p \to \bar{p}p$ obtained by scan of 1540 pictures was 664. Measurement was performed with a film plane digitizer (Vanguard) for the $\bar{p}p \to \bar{n}n$ and with an image plane digitizer (D-MAC) for the $\bar{p}p \to \bar{p}p$, least counts of which were 2.5 μm and 5.0 μm, respectively. Peaks of the distribution of total residuals were at around 4 μm in both measurements. For analysis of the $\bar{p}p \to \bar{n}n$, each event was weighted by detection probability of annihilation stars of $\bar{n}$. Cross sections of the $\bar{p}p \to \bar{n}n$ and $\bar{p}p \to \bar{p}p$ were (9.9 ± 1.1) mb and (53.5 ± 3.0) mb respectively. The angular distributions were given as a function of four momentum transfer squared t and center of mass angle θ^*. Dependence of the cross section on t was represented by a diffraction model; $(d\sigma/dt = AJ_1^2[(a + t/\hbar)\sqrt{|t|}]/t$, $A = b + ct$. The angular distributions at 232 MeV were well reproduced with parameters a = 1.04 fm, b = 29.4 mb, and c = 49.5 mb$\cdot$fm^{-1}, and with t = 0.60 fm. (auth)

59267 DI-PION PRODUCTION AND TWO-BODY ANNIHILATIONS IN ANTIPROTON-PROTON INTERACTIONS AT 7 GeV/c. **Mandzy, John.** Nashville; Vanderbilt Univ. (1971). 147p. University Microfilms Order No. 71-20,297.

Thesis.

The final states $\bar{p}p\pi^+\pi^-$, $\bar{p}p\bar{p}p$, K^+K^-, and $\pi^+\pi^-$ were analyzed in antiproton-proton interactions at a beam momentum of 7 GeV/c. None of the events processed successfully fit the final state $\bar{p}p\bar{p}p$. At the 95% confidence level, this corresponds to an upper limit on the cross section for this final state of 5 μb. In scanning for event candidates for the final states K^+K^- and $\pi^+\pi^-$, scanning cuts were employed in order to remove some of the background. This experiment is therefore only sensitive to K^+K^- and $\pi^+\pi^-$ final states whose four-momentum transfer (between the incoming positively charged particle and the outgoing positively charged particle) lies in a certain region. For the K^+K^- final state this region was: $t_{min} = 0.36 \leq t_p/K^+ \leq 0.73$ and $11.8 \leq t_p/K^+ \leq 12.5 = t_{max}$. For the $\pi^+\pi^-$ final state this region was: $t_p/\pi^+ = 0.58 \leq t_{p/\pi^+} \leq 0.92$ and $12.0 \leq t_{p/\pi^+} \leq 13.6 = t_{max}$. None of the events processed success-

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fully fit either of these two final states. At the 95% confidence level, this corresponds to an upper limit on the cross section for each of the final states of 5 μb. The total cross section for the final state $\bar{p}p\pi^+\pi^-$ was found to be (2.38 ± 0.13) mb. This channel is dominated by production of the N*(1236) in both the $\bar{N}^{*--}$ states and N^{*++} states. The observed mass and width for both the $\bar{N}^{*--}$ and N^{*++} were (1225 ± 7) MeV and (110 ± 15) MeV, respectively. An attempt was made to understand N*(1236) production as the incoherent sum of three processes: single isobar production, double isobar production, and nonisobar processes. The relative amount of each of these processes is, respectively: somewhat greater than 42%, between 34% and 45%, and on the order of 13% to 23%. The data indicate that the N*(1236) production mechanism is highly peripheral. The Treiman–Yang angular distribution of the isobar decays is flat as expected for pion exchange. The distribution of the Jackson angle is less peaked than expected for simple pion exchange and it also shows a significant forward-backward asymmetry. This asymmetry suggests background interference in addition to the usual absorptive processes. The data were compared with the predictions of a particular one-pion-exchange model, the "double scattering" model. There was good agreement between mass plots predicted by the model and the data in the kinematic region in which the comparison was made. There is good evidence for two signals in the $N\pi\pi$ mass spectrum. Their masses are (1460 ± 12) MeV and (1712 ± 12) MeV, and their widths are estimated to be (61 ± 35) MeV and (112 ± 43 MeV), respectively. Neither of these enhancements is a kinematic reflection of the production of an isobar with the remaining baryon as each of these signals is considerably enhanced when such events are deleted. The dominant decay mode of the 1712 MeV signal appears to be via an uncorrelated $N\pi\pi$ state. There is also good evidence for the ρ_0 meson, having a mass of (765 ± 25) MeV and an estimated width of (75 ± 21) MeV. The estimated cross sections for these three signals are 1460 MeV – (60 ± 24) b, 1712 MeV – (136 ± 45) μb, ρ_0 – (52^{+32}_{-16}) μb. (Diss. Abstr.)

59268 ISOSPIN INVARIANCE IN THE REACTION $np \to \pi^0 d$. Wilson, S. S. (Univ. of Michigan, Ann Arbor); Longo, M. J.; Young, K. K.; Helland, J. A.; Schrock, B. L. Nucl. Phys.; B33: No. 1, 253-80(1971).

A measurement of the differential cross section for the reaction $np \to \pi^0 d$ was made at the Lawrence Radiation Laboratory 184-inch cyclotron. A neutron beam with kinetic energies up to 720 MeV was incident on a liquid hydrogen target. The angle and momentum of the deuterons were measured using an analyzing magnet and wire spark chambers with a magnetostrictive readout. Deuterons were separated from protons by time-of-flight. The photons from the decaying π^0 were not detected. The neutron energy was calculated from the measured deuteron angle and momentum. Out of 5×10^5 events recorded, 1.1×10^5 events were the desired $\pi^0 d$ reaction. The cross sections were compared to those for the reaction $\pi^+ d \to pp$ as a test of isotopic spin invariance in strong interactions. The symmetry of the cross sections about 90° was also investigated, and an upper limit of about 1% was placed on the real part of the ratio of isospin-violating to isospin-conserving amplitudes. (auth)

59269 COMPARISON OF HIGH-ENERGY HADRON–DEUTERON SCATTERING DATA WITH THE GLAUBER MODEL. Bradamante, F.; Conetti, S.; Fidecaro, G.; (and others). Nucl. Phys.; B33: No. 1, 165-72(1971).

The results of a series of experiments on $\pi^- d$ and pd elastic scattering in the 10 GeV region are compared with the prediction of the Glauber multiple scattering model. A disagreement is found in the double scattering region, which does not seem to be explainable in terms of the uncertainty in our current knowledge of the individual hadron-nucleon differential cross section. A way of restoring agreement could be that of reducing the usually quoted amount of screening between the two nucleons in the deuteron. (auth)

59270 POLARIZATION AND DIFFERENTIAL CROSS SECTION FOR THE REACTION $pp \to \pi^+ d$ AT 425 MeV. Dolnick, Carl L. (Univ. of Chicago). Nucl. Phys.; B22: No. 2, 461-77(1970).

Differential cross sections and polarizations for the reaction $pp \to \pi^+ d$ were measured at an incident polarized proton energy of 425 MeV (lab) over the range of meson angles 10 to 90 deg in the c.m. system. The final-state pion and deuteron were detected in coincidence in two sets of scintillation counter arrays and the data were analyzed by an on-line computer. Evidence is found for the presence of d-wave mesons. The value 1.30 ± 0.06 mb is obtained for the total cross section. (auth)

59271 ANNIHILATION PROCESS $p\bar{p} \to 2\pi^+ 2\pi^-$ AT 2.5 GeV/c. Clayton, J. (Univ. of Liverpool); Mason, P.; Muirhead, H.; (and others). Nucl. Phys.; B22: No. 1, 85-92(1970).

Abundant resonance production was observed in this reaction, the channels $\rho^0\pi^+\pi^-$, $f\pi^+\pi^-$ accounting for 51 ± 3% and 39 ± 3% respectively of all $2\pi^+ 2\pi^-$ annihilations. No evidence of the A_2 meson was found. Data on the possible existence of the two-pion decay model of the S*(1070) are given. The Reggeised multiperipheral model of Chan, Łoskiewicz and Allison was applied to the reaction, and reasonable agreement between predictions and experimental data found. (auth)

59272 STUDY OF $\bar{p}p$ ANNIHILATION AT 2.5 GeV/c WITH PRODUCTION OF TWO KAONS IN FINAL STATE. Badier, J. (Ecole Polytechnique, Paris); Bonnet, A.; Drevillon, B.; (and others). Nucl. Phys.; B22: No. 2, 512-24(1970).

Cross sections for final states and resonance production are given and compared to a statistical model proposed by Lamb. Transverse and longitudinal momenta are studied and the Goldhaber effect is tested. Baryon exchange mechanisms appear. (auth)

59273 pp AND pd ELASTIC SCATTERING AT 50 AND 70 GeV. Devenski, P. A.; Zayachki, V. I.; Zlatanov, Z. M.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 2, 367-70(Aug 1971). (In Russian).

The experiment is performed at the Serpukhov accelerator. The differential cross sections of the pp elastic scattering at 50 GeV and of the pd elastic scattering at 70 GeV are determined using the method of recoil particle registration by the nuclear emulsion. The region of the 4-momentum transfers $0.01 < |t| < 0.17\ (\mathrm{GeV}/c)^2$ was studied. The slope parameters were determined. The following results have been obtained: $b_{pp} = 11.06 \pm 0.28\ (\mathrm{GeV}/c)^{-2}$ and $b_{pd} = 40.7 \pm 0.7\ (\mathrm{GeV}/c)^{-2}$. (auth)

59274 NONRELATIVISTIC PARTICLES PRODUCED IN INTERACTIONS OF MULTICHARGED COSMIC RAY NUCLEI WITH LIGHT NUCLEI OF EMULSION. Dudkin, V. E.; Potapov, Yu. V.; Khokhlova, Z. S.; Shimanskaya, N. S.; Yakovlev, R. M. Yadern. Fiz.; 14: No. 2, 378-81(Aug 1971). (In Russian).

The results are presented of studying grey and black tracks in 82 events of multicharged cosmic ray nuclei ($E \geq 700$ MeV/nucleon) interaction with light nuclei of the emulsion. The energy distribution of the double-charged particles produced in such interactions is much more hard than that in the nucleon–nuclear collisions. The mean energy of the double-charged particles in the nuclear–nuclear ($Z \geq 3$) interactions is three as high as in the case of high-energy proton collisions with light nuclei. (auth)

59275 EXPERIMENTAL COMPARISON OF $\bar{d}p$ AND $\bar{p}d$ TOTAL CROSS SECTIONS. Gorin, Yu. P.; Denisov, S. P.; Donskov, S. B.; (and others) (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 14: No. 1, 134-6(Jul 1971). (In Russian).

Antideuteron–proton (at the momentum of 13.3 GeV/c) and antiproton–deuteron (p = 6.65 GeV/c) total interaction cross sections are measured in order to test the CPT invariance. The experiments are carried out by means of the transmission counters in conditions of good geometry. The ratio of the $\bar{d}p$ and $\bar{p}d$ total cross sections is found to be 1.002 ± 0.024. The $\bar{d}d$ and $\bar{p}p$ total cross sections are also measured. The obtained data enable one to determine the total cross sections of interactions of antineutrons with protons, neutrons, and deuterons. (auth)

59276 STUDY OF THE REACTION $\bar{p}d \to p_s\pi^+2\pi^-\pi^0$ AT 5.5 GeV/c INCIDENT MOMENTUM. Braun, H.; Evrard, D.; Fridman, A.; (and others) (Centre de Recherches Nucleaires, Strasbourg). Z. Phys.; 247: No. 2, 107-116(1971).

A study of a 150,000-picture exposure of $\bar{p}d$ at 5.5 GeV/c yielded 152 events satisfying the hypothesis $\bar{p}d \to p_s\pi^+2\pi^-\pi^0$. For the events with proton spectator in the momentum range 100 to 280 MeV/c one obtained the cross section of 0.11 ± 0.02 mb. Assuming the validity of the impulse approximation a cross section of 0.43 ± 0.06 mb is estimated for the reaction $\bar{p}n \to \pi^+2\pi^-\pi^0$. The rate for single p meson production and an upper limit for double p production are given. A modified multiperipheral Regge model was used in order to describe the general features of the data. (auth)

59277 ANGULAR DISTRIBUTION OF SECONDARY PARTICLES PRODUCED IN THE INTERSECTING STORAGE RINGS AT AN ENERGY EQUIVALENT TO 1500 GeV. Phys. Lett.; 36B: No. 6, 611-14(18 Oct 1971).

The angular distribution of secondary relativistic charged particles was measured in the ISR by means of nuclear emulsions used as detectors. The result confirms the cosmic-ray observations of a dip in the angular distribution around 90° in the centre-of-mass system of the colliding protons. (auth)

59278 ENERGY SPECTRUM OF ^{8}Li FRAGMENTS RESULTING FROM BOMBARDMENT OF AgBr BY 28 GeV PROTONS. Kane, G. (Manhattan Coll., New York); O'Friel, Z. Lett. Nuovo Cim.; 2: No. 15, 799-804(9 Oct 1971).

Ilford G-5 emulsions 600 μ thick were exposed to 28-GeV protons. 1272 "hammer tracks," characteristic of lithium-8 were located. The measured lengths of the tracks were converted to energies by means of range–energy tables. (L.B.S.)

Strong (Meson-Induced)

Refer also to abstracts 59480, 59499, and 59713.

59279 SPIN PARITY STUDIES OF THE ETA PI DECAY OF THE A2 MESON AND INVESTIGATION OF THE A2 PRODUCTION MECHANISM IN THE REACTION PI-MINUS PROTON GOES TO A2-MINUS PROTON. Lacy, Jeffrey Linn. Urbana, Ill.; Univ. of Illinois (1971). 113p. University Microfilms Order No. 71-21,164.

Thesis.

The results of a spin-parity analysis of the $\eta\pi^-$ decay mode of the A_2^- meson produced in the reaction $\pi^- p \rightarrow A_2^- p$ are presented. Data for the analysis are drawn from bubble chamber experiments between 3.9 and 16 GeV/c. The analysis favors $J^P = 2^+$ for both the upper and lower regions of the A_2. Possible evidence for a weakly produced $J^P = 1^-$ daughter state is also presented. The evidence comes largely from an interference effect observed in the lower A_2 region. Using the $A_2^- \rightarrow \eta\pi^-$ data along with data on the decay channel $A_2^- \rightarrow \rho^0\pi^-$ at 5.0, 7.5, and 11.2 GeV/c, the production mechanism of the A_2^- in the reaction $\pi^- p \rightarrow A_2^- p$ is investigated. Assuming that this reaction is dominated by a t channel exchange mechanism the isospin and J parity of the exchange are investigated. The s and t cross section dependence of the data is compared with a simple Regge model. (Diss. Abstr.)

59280 STUDY OF Λ AND Σ^0 FINAL STATES PRODUCED BY THE INTERACTION OF K^- MESONS ON DEUTERIUM AT 4.5 GeV/c. Ammann, Arthur Carl. Lafayette, Ind.; Purdue Univ. (1971). 154p. University Microfilms Order No. 71-20,419.

Thesis.

The study of four-body final states produced by the interaction of 4.48-GeV/c K^- mesons on neutrons is made. The data result from a 370,000-picture exposure taken of the deuterium filled Mura thirty inch bubble chamber at the Argonne Zero Gradient Synchrotron. Reactions studied include $K^- n \rightarrow \Lambda\pi^+\pi^-\pi^-$ (1), $K^- n \rightarrow \Sigma^0\pi^+\pi^-\pi^-$, $\Sigma^0 \rightarrow \Lambda\gamma$ (2), $K^- n \rightarrow \Lambda\pi^+\pi^-\pi^-\pi^0$ (3), $K^- n \rightarrow \Lambda\pi^+\pi^-\pi^-$mm (4), and $K^- n \rightarrow \Lambda\pi^- K^+ K^-$ (5), where all Λ particles decayed to a visible vee. Unusual detail is presented regarding the separation of reactions (1) and (2). This is done primarily to facilitate the study of the recently reported Σ (1640) seen in reaction (1). Production mechanism and branching ratios are investigated. The charged three-pion spectrum shows a significant signal in the A_2 region. The high mass and dominant 3π decay mode of this object are compared with results from pion-nucleon interactions. Angular distributions show no inconsistency with a 2^+ spin parity assignment. Vector mesons are studied primarily in conjunction with simultaneous Σ^- (1385) production. These quasi-two body reactions are seen to proceed peripherally probably by a combination of strange meson exchange. Spin-density matrix elements show marginal agreement with the previous quark model predictions. (Diss. Abstr.)

59281 $K^- p$ CHARGE EXCHANGE AND ELASTIC SCATTERING NEAR 1670 MeV. Golson, James Philip. Durham, N. C.; Duke Univ. (1970). 105p. University Microfilms Order No. 71-21,539.

Thesis.

The reactions $K^- p \rightarrow \bar{K}^0 n$ and $K^- p \rightarrow K^- p$ were studied at center of mass energies near 1670 MeV with data from a 500,000 picture exposure at the Brookhaven National Laboratory Alternating Gradient Synchrotron using the BNL thirty-inch, liquid-hydrogen bubble chamber. Approximately 1100 events consistent with the $K^- p \rightarrow \bar{K}^0 n$ hypothesis and 5100 events consistent with the $K^- p \rightarrow K^- p$ hypothesis were identified. Differential cross sections for the two reactions were obtained. The differential cross sections were expanded in terms of Legendre polynomials as $(d\sigma/d\Omega) = \lambda\!\!\!^-{}^2 \Sigma_m A_m P_m (\cos\theta)$ where $\lambda\!\!\!^-$ is the center of mass wavelength of the incident particle, the A_m is the energy-dependent coefficient, and the $P_m (\cos\theta)$ is the Legendre polynomial. The A_m obtained in this experiment for both reactions agreed well with those presented from other experiments. Additional structure in the narrow-energy region covered in this experiment is suggested by the data. (Diss. Abstr.)

59282 MANY BODY FINAL STATES FROM $\pi^+ d$ INTERACTIONS NEAR 3 GeV/c. Miller, William Joseph. Lafayette, Ind.; Purdue Univ. (1971). 200p. University Microfilms Order No. 71-20,508.

Thesis.

A study was made of the five- and six-charged-particle final states from the interaction of π^+ beams on a deuterium target at a laboratory beam momentum of 2.7 and 3.1 GeV/c. The data were obtained from a film exposure of the 72-inch bubble chamber at the Lawrence Radiation Laboratory at Berkeley, California. Many elementary particle resonances were observed including the η, ω, Δ^{++}, ρ, η′, D, E, f′, δ, and A_2. The masses and widths of each particle were determined, and the spin and parity of the η′, D, and E were analyzed. Data on the η′ were combined with other experiments to determine the SU-3 mixing angle for η and η′ using the Regge-pole Model. (Diss. Abstr.)

59283 STUDY OF BARYON SYSTEMS AND RELATED EFFECTS IN $K^- d$ INTERACTIONS AT 12.6 GeV/c. Antich, Pietro Paolo. Baltimore; Johns Hopkins Univ. (1971). 146p. University Microfilms Order No. 71-21,017.

Thesis.

An analysis of interactions of 12.6 GeV/c K^- mesons in deuterium is reported. This work is primarily devoted to the study of baryon systems. The nature of an enhancement centered at 1.45 GeV is investigated which is observed both in the $(p\pi^-)$ mass spectrum in the reaction $K^- d \rightarrow K^-\pi^- p p_s$ and in the distributions of the $(n\pi^+\pi^-)$ and of the $(p\pi^+\pi^-)$ masses in the reactions $K^- d \rightarrow K^-\pi^-\pi^+ n p_s$ and $K^- d \rightarrow K^-\pi^-\pi^+ p n_s$, respectively. The three reactions are analyzed with a diffraction dissociation model and the relevant cross sections are given. In a study of the production of the Ξ^- and Ω^- hyperons, it is found that the cross section for Ξ^- production is $\sigma = 40 \pm 10\ \mu b$; the cross section for Ω^- production is of the order of 2 μb. The Ξ^- hyperons are produced preferentially in the forward direction in the overall c.m. (i.e., they are aligned with the incoming K^-). From a study of the low $K^-\pi^-$ mass region in the reaction $K^- d \rightarrow K^-\pi^- p p_s$, it is found that the Kπ elastic scattering cross section in the isospin $^3\!/_2$ state is of the order of 2 mb. (Diss. Abstr.)

59284 QUASI-TWO BODY PRODUCTION INVOLVING $Y_1{}^*$ RESONANT STATES IN K^- MESON–PROTON INTERACTIONS AT 3.9, 4.6, AND 5.0 GeV/c. Jaeger, Klaus Bruno. Syracuse, N. Y.; Syracuse Univ. (1970). 309p. University Microfilms Order No. 71-21,522.

Thesis.

A bubble chamber experiment based upon 700,000 pictures of K^- mesons in hydrogen which was performed by groups from Syracuse University and Brookhaven National Laboratory is described. The Brookhaven 80″ liquid hydrogen bubble chamber was exposed to seven different runs of separated K^- beams at 3.9, 4.6, and 5.0 GeV/c. Quasi-two body cross sections were determined for the channels $K^- + p \rightarrow$ (2 charged particles) $+ \Lambda(\Sigma^0)$ and $K^- + p \rightarrow p + \pi^- + \bar{K}^0$ for the 4.6 and 5.0 GeV/c data. The observed values served as an important supplement to other experimental information in exhibiting the quasi-two body cross section behavior as a function of the incident K^- meson laboratory momentum. Production of Y_1^* resonances was studied in the channels $K^- + p \rightarrow \Lambda + \pi^+ + \pi^-$, $K^- + p \rightarrow \Sigma^0 + \pi^+ + \pi^-$; and $K^- + p \rightarrow p + \pi^- + \bar{K}^0$ at the 3.9, 4.6, and 5.0 GeV/c energies. Significant Y_1^{*+} (1915) and Y_1^{*+} (2250) production was only observed in the $\Sigma^0\pi^+\pi^-$ final state with the Y_1^{*+} (1385) and Y_1^{*+} (1670) also seen in the $\Lambda\pi^+\pi^-$ channel. The masses and widths of these resonances within the $\Sigma^0\pi^+\pi^-$ final state were determined as (1390 ± 6) MeV with $\Gamma = (33 \pm 12)$ MeV for the Y_1^{*+} (1385), (1670 ± 6) MeV with $\Gamma = (110 \pm 12)$ MeV for the Y_1^{*+} (1670), (1940 ± 11) MeV with $\Gamma = (90 \pm 20)$ MeV for the Y_1^{*+} (1915), and (2280 ± 14) MeV with $\Gamma = (100 \pm 20)$ MeV for the Y_1^{*+} (2250). Subsequent assignment of the Y^*'s to the SU(3) symmetry scheme yielded good agreement by utilizing the $\Sigma^0\pi^+$ decay rates of the Y_1^{*+} (1915) within the $J^P = {}^5\!/_2{}^+$ baryon octet and of the Y_1^{*+} (2250) within the ${}^7\!/_2{}^-$ octet. The Σπ and Λπ decay rates of the Y_1^{*+} (1385) are consistent with predicted SU(3) rates within the ${}^3\!/_2{}^+$ decuplet. Decay rates obtained in formation experiments for the Y_1^{*+} (1670) are consistent with SU(3) predictions for the ${}^3\!/_2{}^-$ baryon octet. The result of the Y_1^{*+} (1670) $\rightarrow \Sigma^0\pi^+$ rate from this experiment is much larger and subsequently inconsistent with SU(3) predictions. Hence the Y_1^{*+} (1670) decay parameters for the presented data were not employed within the context of SU(3) leaving the possible existence of more than one Y^* resonance in this final state for this mass region open for further experimental study. (Diss. Abstr.)

59285 STUDY OF INTERMEDIATE ANGLE $\pi^{+-} p$ ELASTIC SCATTERING FROM 3.0 to 5.0 GeV/c. Paik, Han Won. Bloomington, Ind.; Indiana Univ. (1971). 69p. University Microfilms Order No. 71-21, 308.

Thesis.

A study is made of a $\pi^{\pm} p$ elastic scattering experiment performed at the Argonne National Laboratory Zero-Gradient Synchrotron. Both positive and negative pions at incident momenta of 3.0, 3.5, 4.0, and 5.0 GeV/c were incident on a liquid hydrogen target, and the scattered particles were detected by arrays of scintillation counters and wire spark chambers. The geometry of the experimental layout was such as to cover an angular range

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from 55 to 130° in the center of mass frame. Both π^+ and π^-p angular distributions are characterized by the presence of a nonshrinking forward diffraction peak, a dip or shoulder near $t = -0.9$ $(GeV/c)^2$ and a deep minimum near $t = -3.0$ $GeV/c)^2$, all of which were previously observed in experiments at momenta above 2.5 GeV/c. In addition the data show the presence of a shoulder for π^+p and indicate another minimum for π^-p. Both occur approximately at a constant value of $\theta_{c.m.} = 125°$. The experimental results can be described either using an optical model or in terms of a t-channel Regge exchange model. (Diss. Abstr.)

59286 OBSERVATION OF NATURAL-PARITY EXCHANGE IN ρ^0 PRODUCTION. Carroll, J. T. (Univ. of Wisconsin, Madison). Firebaugh, M. W.; Walker, W. D.; (and others). Contract AT(11-1)-881. Phys. Rev. Lett.; 27: No. 15, 1025-8(11 Oct 1971).

In a study of $\pi^-p \rightarrow \rho^0n$ and $\pi^+n \rightarrow \rho^0p$ at 7 GeV/c, a distinct change in the $\pi\pi$ angular distribution is observed for $|t_{np}| \geq 0.3$ $(GeV/c)^2$. Here there is a strong $\sin^2\theta \sin^2\varphi$ term in the decay angular distribution, which is indicative of natural-parity exchange. The observed effects are attributed to A_2 exchange. (auth)

59287 ISOSPIN INVARIANCE AND πN BACKWARD SCATTERING. Korkea-Aho, M.; Toernqvist, N. A. (Univ. of Helsinki). Nucl. Phys.; B33: No. 1, 239-52(1971).

The predictions of isospin invariance in πN backward data from threshold to 13 GeV/c are studied. Below 1.5 GeV/c especially below 1 GeV/c the present published experimental data systematically saturate and even violate the triangle inequality implied by isospin invariance. Conventional electromagnetic corrections or mass and width differences in formed resonances (as e.g., the Δ^{++} and Δ^0) are an order of magnitude too small to explain the discrepancy. Thus either there are large systematic errors in the data or isospin invariance is violated, inherently or by strongly enhanced electromagnetic effects. Above 1.5 GeV/c the inequality is satisfied by the data and the expected high-energy behavior from the Regge model of Δ and N_α dominance is discussed. Duality and exchange degeneracy predictions of phase relations between isospin amplitudes are used to speculate on the possible connection between duality and the fact that the data lie close to the limit of the inequality. (auth)

59288 PRODUCTION OF THE g-MESON IN $\pi N \rightarrow g^0N$ CHARGE EXCHANGE CHANNELS AT 7 GeV/c. Matthews, J. A. J. (Univ. of Toronto); Prentice, J. D.; Yoon, T. S.; (and others). Nucl. Phys.; B33: No. 1, 1-12(1971).

Data from π^+d and π^-p experiments at 7 GeV/c were combined to yield 10654 events in the $\pi^+\pi^-$ mass spectrum. A spin-parity analysis of this data favors a spin-parity assignment of $J^P = 3^-$ for the $g^0(1670)$ meson. Spin-parities 1^- and 5^- were not in agreement with our data. An analysis of the differential cross section for ρ^0, f^0, and g^0 production using the one-pion exchange model plus form factors was consistent with significant widths for g^0 decays to channels other than $\pi^+\pi^-$, while being in good agreement with the experimental branching ratios for ρ^0 and f^0 mesons. (auth)

59289 DEDUCTIONS FROM NEW $\pi^-p \rightarrow \pi^0n$ DATA AT LARGE MOMENTUM TRANSFERS. Barger, V. (Univ. of Wisconsin, Madison); Phillips, R. J. N. Contract AT(11-1)-881. Nucl. Phys.; B33: No. 1, 22-8(1971).

New measurements of $d\sigma/dt$ $(\pi^-p \rightarrow \pi^0n)$ at 3.67 and 4.83 GeV/c suggest that the ρ Regge trajectory continues to fall linearly out to $t = -5$ $(GeV/c)^2$. A comparison with elastic data indicates furthermore that the dips in $d\sigma/dt$ $(\pi^{\pm}p)$ near $t = -2.8$ and -4.8 $(GeV/c)^2$ are associated with zeros of the t-channel isospin-zero (vacuum exchange) contributions. Both these properties indicate that a t-channel explanation is appropriate through the range $-t < 5$ $(GeV/c)^2$. The triangular inequalities following from isospin invariance all seem to be satisfied, but imply collinearity of the $I_t = 0$ and $I_t = 1$ amplitudes near $t = -4.3$; this is a difficult condition for some models to meet. (auth)

59290 FURTHER EVIDENCE FOR THE DECAY MODE $X^0 \rightarrow \gamma\gamma$ AND DETERMINATION OF THE BRANCHING RATIO $X^0 \rightarrow \gamma\gamma/X^0 \rightarrow$ TOTAL. Basile, M.; Bollini, D.; Dalpiaz, P.; (and others) (CERN, Geneva. Istituto Nazionale di Fisica Nucleare, Bologna. Univ., Bologna. Centre National de Recherches Scientifiques, Strasbourg). Nucl. Phys.; B33: No. 1, 29-41 (1971).

41 ± 8 events of the type $X^0 \rightarrow \gamma\gamma$ were observed in a study of the reaction $\pi^-p \rightarrow n(X^0 \rightarrow \gamma\gamma)$ at 1.6 GeV/c incident π-momentum. This provides further evidence to our previous observation of this new X^0 decay mode and allows the determination of the branching ratio $\Gamma(X^0 \rightarrow \gamma\gamma)/\Gamma(X^0 \rightarrow \text{total}) = (1.7 \pm 0.4)\%$. The theoretical implications of this result are discussed. (auth)

59291 EXPERIMENTAL STUDY OF TWO-BODY AND QUASI-TWO-BODY REACTIONS IN K^-n INTERACTIONS AT 3 GeV/c. Scheuer, J. C. (CEN, Saclay, France); Barloutaud, R.; Merrill, D.; (and others). Nucl. Phys.; B33: No. 1, 61-83(1971).

All data accumulated in the study of the (quasi) two-body reactions produced in K^-n interactions at 3 GeV/c are presented. From the general features of the differential cross sections, as well as from the smallness of exotic amplitudes in the t-channel, it appears that the forward and backward scatterings should be well described even at this energy by t- and u-channel interactions. (auth)

59292 π^+p ELASTIC SCATTERING AT 3.6 GeV/c. MacNaughton, J.; Butler, W. R.; Coyne, D. G.; Hicks, G. M.; Trilling, G. H. (Univ. of California, Berkeley). Nucl. Phys.; B33: No. 1, 101-8 (1971).

The elastic scattering of 3.6 GeV/c π^+ mesons by protons was studied in a hydrogen bubble chamber experiment. The elastic cross section has a measured value of 7.07 ± 0.20 mb. The forward diffraction peak has been fitted in the region $0.05 \leq -t \leq 0.6$ $(GeV/c)^2$ by a form $(d\sigma/dt) = Ae^{Bt}$, where $A = 46.5 \pm 1.8$ mb/. $(GeV/c)^2$ and $B = 6.85 \pm 0.20$ $(GeV/c)^{-2}$. From this fit and the optical theorem, the magnitude of the ratio of real to imaginary forward amplitude is 0.39 ± 0.06, in reasonable agreement with dispersion relation calculations and simple Regge model predictions. (auth)

59293 IMPROVED PARTIAL WAVE ANALYSIS OF $\bar{K}N \rightarrow \bar{K}N$ FROM 800 TO 1200 MeV/c. Conforto, B. (Univ. of Chicago); Harmsen, D. M.; Lasinski, T.; (and others). Nucl. Phys.; B34: No. 1, 41-70(1971).

An extensive search for resonant states was performed through an energy dependent partial wave analysis of $\bar{K}N$ data in the momentum region 777–1226 MeV/c. The $K^-p \rightarrow K^-p$, $\bar{K}^0n$ differential cross sections, polarization angular distributions and total K^-p cross sections were included in the fit. In addition to the well established hyperons, evidence is reported for a resonant state $\Sigma(1760)$ of $J^P = \frac{1}{2}^-$ and for the assignment $J^P = \frac{3}{2}^+$ for a $\Lambda(1870)$ state previously assigned to $J^P = \frac{7}{2}^+$. From the $K^-p \rightarrow K^-p$ differential and total cross sections between 436 and 1226 MeV/c the ratio of the real to the imaginary part of the forward scattering amplitude has been derived as a function of K^- incident momentum. These results are found to be consistent with the predictions of several dispersion relation calculations. (auth)

59294 MEASUREMENT OF THE MAGNETIC MOMENT OF THE Λ^0 HYPERON. Barkov, L. M.; Gurevich, I. I.; Makar'ina, L. A.; (and others). JETP Lett. (USSR) (Engl. Transl.); 14: No. 2, 60-3(20 Jul 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 2, 93-7(20 Jul 1971).

Preliminary results are given on a new measurement of the magnetic moment of the Λ^0 hyperon produced in the $\pi^- + p \rightarrow \Lambda^0 + K^0$ interaction. The hyperons were produced in a polyethylene target and their decays $\Lambda^0 \rightarrow p + \pi^-$ were detected in an emulsion stack. From 49 events the magnetic moment of Λ^0 was determined to be $\mu_{\Lambda^0} = -0.67 \pm 3$ nm. (L.B.S.)

59295 ANTI-LAMBDA PRODUCTION IN K^+p INTERACTIONS AT 8.25 GeV/c. Charriere, G. (CERN, Geneva); Drijard, D.; Dunwoodie, W.; (and others). Nucl. Phys.; B22: No. 2, 333-42 (1970).

We present the data on the $\bar{\Lambda}(\bar{\Sigma})$ events produced in final states of K^+p interactions at 8.25 GeV/c. Cross sections for $\bar{Y}^0$ production are given for most final states obtained in this experiment, and the results at other energies are listed for comparison. No significant enhancement is seen in the $\bar{Y}^0$ N mass distributions while there is some indication of the production of $\bar{Y}^*(1385)$ and $N^*(1236)$ in the $\bar{\Lambda}\pi$ and $N\pi$ systems respectively. An attempt at the description of the reaction $K^+p \rightarrow \bar{\Lambda}pp$ in terms of a five-point Veneziano amplitude is also included. (auth)

59296 $\pi\pi$ SCATTERING EFFECTS IN π^+p INTERACTIONS AT 8 GeV/c. Bartsch, J. (Technische Hochschule, Aachen); Keppel, E.; Schulte, R.; (and others). Nucl. Phys.; B22: No. 1, 1-15(1970).

The reaction $\pi^+p \rightarrow \Delta^{++}\pi^+\pi^-$ at 8 GeV/c was used to study $\pi\pi$ scattering in the ρ-meson mass region. Two different methods were used. In the first, it is assumed that $\pi\pi$ scattering in this mass range is entirely elastic and confined to S-, P- and D-waves. The P- and D-waves are assumed to be given by the ρ^0 and f^0 resonant amplitudes extrapolated off-shell using Dürr–Pilkuhn form factors. The remaining cross section (which by our assumption is S-wave) fits a Breit–Wigner distribution with $m_S = 680 \pm 30$ MeV and $\Gamma_S^0 = 310 \pm 70$ MeV. In the second method a $\pi\pi$ phase-shift analysis was used to obtain the S-wave phase shifts. There are two possible solutions here, one of which resonates at $m_S = 710 \pm 80$ MeV and $\Gamma_S^0 = 140 \pm 20$ MeV. (auth)

59297 STUDY OF CROSS SECTIONS AND SPIN-DENSITY MATRIX ELEMENTS FOR TWO-BODY REACTIONS IN 5 GeV/c π^+p TWO-PRONGED INTERACTIONS. Schotanus, D. J. (Univ., Nijmegen, Netherlands); Pols, C. L.; Toet, D. Z.; (and others). Nucl. Phys.; B22: No. 1, 45-65(1970).

Results are presented on differential (total) cross sections and decay parameters for four two-body reactions ($\pi^+p \rightarrow p\pi^+$, $\pi^+p \rightarrow p\rho^+$, $\pi^+p \rightarrow \Delta^{++}\pi^0$ and $\pi^+p \rightarrow \Delta^{++}\eta^0$) obtained from a sample of approximately 30,000 two-pronged interactions at 5 GeV/c incident momentum. In the forward direction the $d\sigma/dt'$ distribution of reactions $p\rho^+$, $\Delta^{++}\pi^0$ and $\Delta^{++}\eta^0$ shows a dip or flat region. The general $d\sigma/dt'$ structure of the elastic channel and the reaction $p\rho^+$ requires a "double-slope" fit. The $d\sigma/dt'$ distribution of reaction $\pi^+p \rightarrow \Delta^{++}\pi^0$ shows a clear-cut dip at $t' \approx 0.6$ GeV^2. In the backward region peaks are observed for reactions $\pi^+p \rightarrow p\pi^+$, $p\rho^+$ and $N^{*+}(1660)\pi^0$. The $d\sigma/d|u|$ distribution of the elastic channel shows a dip at $|u| \approx -0.2$ GeV^2. The spin-density matrix elements of the ρ^+ particle in reaction $p\rho^+$ indicate the presence of both π- and ω-trajectory exchange. The spin-density matrix elements of the Δ^{++} in the reactions with final state $\Delta^{++}\pi^0$ and $\Delta^{++}\eta^0$ are compatible with pure ρ and A_2 Regge trajectory exchange respectively. Where applicable, the $d\sigma/dt'$ and density matrix element results are compared with the Dar–Weisskopf absorption model and with the predictions resulting from Regge-pole model fits. (auth)

59298 **g-MESON. Bartsch, J. (Technische Hochschule, Aachen); Kraus, G.; Tsanos, N.; (and others). Nucl. Phys.; B22: No. 1, 109-30(1970).**

The present status of our knowledge of the properties of the g-meson is summarized and discussed. New results obtained by the ABC collaboration in an 8 GeV/c π^+p experiment, concerning $(2\pi)^+$ and $(4\pi)^+$ enhancements at about 1700 MeV, are presented. For the question of the g-meson spin, it is shown that the two types of determinations based on analyses of the decay angular distributions published in the literature, as well as the analysis attempted on these 8 GeV/c results, all favoring $J^P = 3^-$, cannot be considered as definitive. A third method of spin analysis is here tried, based on a study of the g-meson cross section as a function of the g-meson spin and elasticity, using the OPE model. This new method is a general one which could be applied to other resonances with production mechanism similar to that of the g-meson. It is found that in the framework of this model, (a) irrespective of the spin assignment, the g-meson must have elasticity $\eta < 1$, which means that the $g \rightarrow 2\pi$ and at least part of the 4π enhancement are the same object, (b) assuming that all the 4π enhancement derives from the g-meson, the experimental value of the elasticity $\eta \approx 0.4$ favors $J^P = 3^-$. (auth)

59299 SIX- AND SEVEN-BODY FINAL STATES IN K^+p INTERACTIONS AT 5 GeV/c. **De Baere, W. (Laboratoire Interuniversitaire Belge des Hautes Energies, Brussels); Debaisieux, J.; De Wolf, E.; (and others). Nucl. Phys.; B22: No. 1, 131-49(1970).**

A study of six- and seven-body final states among the K^+p interactions at 5 GeV/c incident K^+ momentum is presented. Results on cross sections, resonance and single-particle productions are given. Charge dependent angular correlations for pairs of pions occur as in $\bar{p}p$ and π^+p interactions (the so called GGLP effect). In contrast, no dependence on the charge is observed in the angular correlations between kaons and pions. The influence of the production of K^* and N^* resonances on these angular correlations is investigated. The predictions of a multi-Regge Model (CLA) are compared to the experimental results. (auth)

59300 APPLICATION OF A MULTI-REGGE MODEL TO THE REACTION $\pi^-p \rightarrow p\pi^+\pi^-\pi^-\pi^0$ AT 13 AND 20 GeV/c. Brandenburg, G. W.; Brenner, A. E.; Heyda, D.; (and others) (Harvard Univ., Cambridge, Mass.). Nucl. Phys.; B22: No. 1, 157-78(1970).

Data from the reaction $\pi^-p \rightarrow p\pi^+\pi^-\pi^-\pi^0$ at 13 and 20 GeV/c are compared with the predictions of the Reggeized multiperipheral model of Chan, Łoskiewicz and Allison. The model is in good agreement with the single-particle momentum distributions and adequately reproduces the shape of the non-resonant regions of the invariant-mass distributions. (auth)

59301 REACTION $\pi^-p \rightarrow K^+K^-n$ BETWEEN 988 AND 1100 MeV INVARIANT KK MASS. Hyams, B. D. (CERN, Geneva); Koch, W.; Potter, D. C.; (and others). Nucl. Phys.; B22: No. 1, 189-204(1970).

The results of an optical spark chamber experiment studying the reaction $\pi^-p \rightarrow K^+K^-n$ at 11.04 GeV/c π^- momentum are studied. The apparatus measured the K^+K^- system over all decay orientations up to a mass of 1100 MeV and $|t| \leq 0.5$ (GeV/c)^2. The observed mass spectrum comprises a superposition of a slowly varying S-wave and P-wave, the ϕ-resonance, and a small bump at 1063 MeV. The spin-density matrix elements of the K^+K^- system are presented and discussed. The ϕ-mass and width were determined to be $M = 1018 + 0.5(-0.35)$ MeV, $\Gamma = 3.3 + 1.5 (-0.9)$ MeV. (auth)

59302 K^-d ELASTIC SCATTERING AND $K^-d \rightarrow K^-pn$ BETWEEN 810 AND 1110 MeV/c. Jew, N. N.; Kalmus, G. E. (Univ. of California, Berkeley). Nucl. Phys.; B22: No. 1, 205-24(1970).

Angular distributions for the reactions $Kd \rightarrow Kd$ and $Kd \rightarrow Kpn$ at incident K^- momenta of 810, 910, 1010 and 1110 MeV/c are presented. Data are also presented on K^-n elastic scattering assuming the impulse approximation is valid. (auth)

59303 PARTIAL WAVE ANALYSIS OF $K^-N \rightarrow \Lambda\pi$ BETWEEN 1.0 AND 1.85 GeV/c. Litchfield, P. J. (Rutherford High Energy Lab., Chilton, Eng.). Nucl. Phys.; B22: No. 1, 269-84(1970).

A partial wave analysis was performed on a compilation of the world's data on the reaction $K^-N \rightarrow \Lambda\pi$ in the range of incident beam momenta between 1.0 and 1.85 GeV/c. The resonance parameters of the $F_7\Sigma(2030)$ are determined to be: mass = 2022 ± 4 MeV, width = 170 ± 15 MeV and $\sqrt{(xx')} = +0.200 \pm 0.008$ and those of the $F_5\Sigma(1910)$ to be: mass = 1895 ± 10 MeV, width = 70 ± 15 MeV, $\sqrt{(xx')} = -0.070 \pm 0.015$. Evidence is also found for resonant behavior in the P_1 wave at 1920 MeV, in the P_3 wave at 2070 MeV and in the D_3 wave at 1940 MeV. (auth)

59304 PARTIAL WAVE AMPLITUDES FOR π^-p ELASTIC SCATTERING AND CHARGE EXCHANGE IN THE 2 TO 5 GeV/c REGION. Roychoudhury, R. K.; Perrin, R.; Bransden, B. H. (Univ. of Durham, Eng.). Nucl. Phys.; B22: No. 2, 573-82(1970).

The experimental data, for the elastic scattering of π^- mesons by protons and for charge exchange in the momentum interval 2 to 5 GeV/c, was fitted by a model in which the amplitudes are represented as the sum of Regge-pole exchange terms and parametric terms based on polynomial expansions in cos θ. Phase-shift parameters are subsequently obtained by partial wave projection, and the resonant structure of the region is tentatively identified. (auth)

59305 **K^+N CHARGE-EXCHANGE REACTION AT 5.5 GeV/c. Cline, D.; Penn, J.; Reeder, D. D. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Nucl. Phys.; B22: No. 1, 247-52(1970).**

The partial cross section and momentum transfer distribution for the reaction $K^+d \rightarrow K^0pp$ was measured at 5.5 GeV/c. The cross section is 174.8 ± 20.0 μb. The differential cross section in the forward direction is compared to the optical point and the KN charge-exchange scattering amplitude is found to be predominately real. A comparison of the data to Regge models and SU(3) sum rules is made. (auth)

59306 EXPERIMENTAL DETERMINATION OF THE LOW MASS I = 0 S-WAVE $\pi\pi$ PHASE SHIFT USING A METHOD WHICH IS CONSISTENT WITH THE OFF-MASS-SHELL DEPENDENCE OF CURRENT ALGEBRA. Scharenguivel, J. H. (Purdue Univ., Lafayette, Ind.); Gutay, L. J.; Miller, D. H.; Meiere, F. T.; Marateck, S. Nucl. Phys.; B22: No. 1, 16-30(1970).

The forward-backward asymmetry $\alpha(s,\Delta^2)$ was extrapolated to both the pion pole and to the $\pi\pi$ threshold in a manner that is consistent with the general form of the off-mass-shell dependence of current algebra. The P-wave and the isoscalar S-wave $\pi\pi$ phase shifts near threshold were determined. (auth)

59307 ANALYSIS OF THE N*(1500) AND N*(1700) BARYON RESONANCES PRODUCED VIA DIFFRACTION DISSOCIATION. **Morse, R. (Univ. of Wisconsin, Madison); Oh, B. Y.; Walker, W. D.; (and others). Contract AT(11-1)-881. Phys. Rev., D; 4: No. 1, 133-40(1 Jul 1971).**

Evidence in the $\pi\pi N$ mass spectrum for the production of two nucleon isobars, the N*(1500) and N*(1700), is reported. They appear to be produced very peripherally, and have the same production cross section at both 7.0 and 25.0 GeV/c, indicating that a nuclear diffraction-dissociation process is dominant. The N*(1500) seems to be $J^P = \frac{1}{2}^+$ and decays principally via $p\sigma$ and not $\Delta^{++}\pi^-$ as previously suggested. The N*(1700) could be the N*(1688) $\frac{5}{2}^+$ decaying partially into $\Delta^{++}\pi^-$, or it could be the N*(1700) $\frac{1}{2}^-$ decaying in a non-$\Delta^{++}\pi^-$ mode riding on a large $\Delta^{++}\pi^-$ $\frac{5}{2}^+$ nonresonant Deck-type background. Finally the ΛK decay of the N*(1700) is observed and evidence presented for it being a $J = \frac{1}{2}$ object. Production of this $\frac{1}{2}^-$ isobar should be forbidden by the Morrison $\Delta P = (-1)^{\Delta J}$ rule. (auth)

59308 EVIDENCE FOR A CHARGE ASYMMETRY ON THE ω DALITZ PLOT. Abrams, G. S.; Barnham, K. W. J.; Butler,

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W. R.; (and others) (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 3, 653-63(1 Aug 1971).

The reaction $\pi^+p \rightarrow \pi^+p\omega$ was studied at 3.7 GeV/c using data from the LRL 72-in. hydrogen bubble chamber. An analysis of the $\omega \rightarrow \pi^+\pi^-\pi^0$ Dalitz plot for ~4000 ω events yields no evidence for $\pi^+\pi^-\pi^0$ states with isospin $I \neq 0$ at the level of 10^{-3} in intensity relative to the $I = 0$ intensity. A similar analysis of ~500 ω events produced in a kinematical region of known $\rho-\omega$ coherence yields no evidence for $\rho^0 \rightarrow \pi^+\pi^-\pi^0$ decays with $I \neq 0$ at the 1% level in intensity relative to the $\rho^0 \rightarrow \pi^+\pi^-$ mode. A significantly nonzero value of the charge asymmetry $\alpha = (N_+ - N_-)/(N_+ + N_-)$ is observed (0.179 ± 0.051) for ω events produced opposite a $\Delta^{++}(1236)$ in the narrow $t' = |t - t_{min}|$ range [0.08 – 0.20 $(GeV/c)^2$]. Four possible origins for the observed interfering amplitude are discussed, whose quantum assignments may be deduced as $I^G = 1^-$, $J^{PC} = 1^{-+}$: (1) C violation in ω decay (which may be ruled out), (2) C violation in $\rho^0 \rightarrow \pi^+\pi^-\pi^0$ decay, (3) a miscellaneous coherent background amplitude with these quantum numbers, and (4) a possible exotic resonant state with these quantum numbers. (auth)

59309 π^+p ELASTIC SCATTERING DATA BETWEEN 1820- AND 2090-MeV c.m. ENERGY. Kalmus, G. E. (Univ. of California, Berkeley); Michael, W.; Birge, R. W.; Fung, S. Y.; Kernan, A. Phys. Rev., D; 4: No. 3, 676-83(1 Aug 1971).

Total and differential elastic cross section data are presented at eight incident π^+ momenta: 1.28, 1.34, 1.40, 1.43, 1.55, 1.68, 1.77, and 1.84 GeV/c. These data were obtained from a hydrogen-bubble-chamber exposure at the Bevatron, and contain more than 65,000 events. This represents more than 1½ times the world's data hitherto available in this energy region. (auth)

59310 BRANCHING RATIO FOR THE DECAY OF ϕ MESONS INTO LEPTON PAIRS. Hayes, S.; Imlay, R.; Joseph, P. M.; Keizer, A. S.; Stein, P. C. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 4: No. 3, 899(1 Aug 1971).

Values of the branching ratio for the decay of ϕ mesons into lepton pairs obtained from colliding-beam experiments are compared with values obtained from photoproduction experiments. (auth)

59311 ADDITIONAL DATA IN THE REACTION $\pi^+p \rightarrow \Sigma^+K^+$ AT 1.28 AND 1.41 GeV/c AND A TEST OF CHARGE INDEPENDENCE IN THE c.m. ENERGY RANGE 1.820 TO 2.090 GeV. Kalmus, G. E.; Borreani, G.; Louie, J. (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 3, 916-18(1 Aug 1971).

Data at two additional π^+ momenta (1.28 and 1.41 GeV/c) in the reaction $\pi^+p \rightarrow \Sigma^+K^+$ are presented. Charge independence is tested over the c.m. energy range 1.820 to 2.090 GeV; the data for the Σ^+K^+ channel and published data for the $\pi^-p \rightarrow \Sigma^0K^0$ and Σ^-K^+ channels were used. (auth)

59312 INVESTIGATION OF THE REACTION $\pi^-p \rightarrow pX^-$ AT THE MOMENTUM OF 3.25 GeV/c WITH HIGH MOMENTUM TRANSFER. Baloshin, O. N.; Vladimirskii, V. V.; Dukhovskoi, I. A.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 1, 131-3(Jul 1971). (In Russian).

The missing mass spectrum for the reaction $\pi^-p \rightarrow pX^-$ is investigated at high momentum transfers by means of the track spectrometer with optical spark chambers in a magnetic field. The initial π^--meson momentum is 3.25 GeV/c. The ρ^--meson production differential cross section is measured in the angle interval $-1.0 \leq \cos\theta^* \leq -0.995$, that is found to be 28.2 ± 9.8 μbarn/sterad. (auth)

59313 COHERENT INTERACTIONS OF PIONS WITH NUCLEAR EMULSION AT ENERGIES OF 17 AND 45 GeV. Azimov, S. A.; Basova, E. S.; Grishin, V. G.; (and others) (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz.; 14: No. 1, 137-49 (Jul 1971). (In Russian).

A method is described to select coherent interactions of high energy particles with complex nuclei that is based on analysis of the two-dimensional distributions of the angular estimates of the longitudinal and transversal momenta, transfered to the target nucleus, in various interaction groups. With this method the mean free paths are obtained for the coherent reactions $\pi^- \rightarrow 2\pi^-\pi^+$ and $\pi^- \rightarrow 3\pi^-2\pi^+$ on the emulsion nuclei at the pion energy of 17 GeV: $52.8^{+6.5}_{-5.2}$ m and $3.8^{+1.5}_{-1.6}$ km respectively; and at the energy of 45 GeV the mean free paths are obtained to be $34.0^{+5.5}_{-4.1}$ m and 195^{+108}_{-52} m. (auth)

59314 π^-p INTERACTIONS AT 3.25 GeV/c. TWO-PRONG EVENTS. Guzhavin, V. M.; Vetlitskii, I. A.; Kaidalov, A. B.; (and others) (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 2, 354-66(Aug 1971). (In Russian).

Two-prong events of π^-p interactions at the incident π^--meson momentum of 3.25 GeV/c were studied using a liquid-hydrogen bubble chamber. The cross sections of certain channels were determined. They were found to be 7.3 ± 0.5; 2.0 ± 0.2; 3.2 ± 0.3; 2.9 ± 0.3; 6.2 ± 0.5 mbn, respectively. It is shown that two reactions in 80% of all the cases occur as quasi-two-particle states. It is found that ρ^- and ρ^0 mesons are produced peripherally and their production cross section is 1.0 ± 0.2 mbn and 1.2 ± 0.2, respectively. The data on the experimental production cross section and on the elements of the ρ^- and ρ^0 meson polarization density matrix were described using two models: the Regge pole model (RPM) and the model accounting both Regge poles and moving branch points (RPMB). In terms of the RPM the contributions of the π, R Regge trajectories into the cross section of reaction $\pi^-p \rightarrow n\rho^0$ (~72%, 28%, respectively) and of R, ω poles into the cross section of reaction $\pi^-p \rightarrow p\rho^-$ (41%) are determined. When describing the experimental data using the RPMB it is shown that the contribution of the πP branch point into the cross section of certain processes and is small. It is found that both models describe satisfactorily the experimental results. (auth)

59315 ANALYSIS OF THE REACTION $\pi^+p \rightarrow \rho^0\Delta^{++}$ AT 11.7 GeV/c INCIDENT MOMENTUM. I. EXPERIMENTAL INVESTIGATION. Maddock, R. O. (Univ. of Durham, Eng.); Pinter, G. F.; Evans, D.; (and others). Nuovo Cim.; 5A: No. 3, 433-56 (1 Oct 1971).

The difficulty in determining the total and the differential cross sections of the double-resonance process $\pi^+p \rightarrow \rho^0\Delta^{++}$ is discussed and a method of determining these is given which involves only few theoretical assumptions. The total cross section is (0.32 ± 0.04) mb. The joint decay angular distribution is analysed in terms of statistical tensor and density matrix elements. The data are consistent with pion exchange. (auth)

59316 PRODUCTION OF $\pi^+2\pi^-$ SYSTEM ON NUCLEI AT SMALL MOMENTUM TRANSFERS. Kirillov-Ugryumov, V. G.; Levina, V. I.; Ponosov, A. K.; Protasov, V. P.; Sergeev, F. M. (Moscow Engineering Physics Inst.). JETP Lett. (USSR) (Engl. Transl.); 14: No. 3, 110-12(5 Aug 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 3, 168-71(5 Aug 1971).

The coherent production of a triplet of pions on light nuclei by π^- with 4 GeV/c momentum was observed in a freon bubble chamber. The mass distributions and cross sections are shown. It is noted that the mass distributions obtained hardly differ from the distributions for higher energies, when the fraction of the coherent reactions is much higher. (J.F.P.)

59317 PARTICLE MOMENTUM DISTRIBUTION FOR 8.5-GeV/c π^+p INTERACTIONS. Cole, J.; Lee-Franzini, J.; Loveless, R. J. (State Univ. of New York, Stony Brook). Phys. Rev., D; 4: No. 3, 627-30(1 Aug 1971).

Two-, four-, six-, and eight-prong events from 8.5-GeV/c π^+p interactions were measured and laboratory distributions of particle momenta were prepared both for the individual classes of events and for the combined sample. (auth)

59318 OBSERVATION OF A NEW $K_N(1760)$ IN THE $K\pi$ AND $K\pi\pi$ SYSTEMS. Carmony, D. D. (Purdue Univ., Lafayette, Ind.); Cords, D.; Clopp, H. W.; (and others). Phys. Rev. Lett.; 27: No. 17, 1160-3(25 Oct 1971).

A new K* resonance, denoted $K_N(1760)$, was observed. Its mass is 1759 ± 10 MeV; and its width, 60 ± 20 MeV. It is assigned to the natural-spin–parity series on the basis of 5-standard-deviation evidence for a $K\pi$ decay mode. Decays into $K^*(890)\pi$ and $K\rho$ with the same mass and width are observed with 4-standard-deviation significance. It is suggested that this state is the analog of the g meson. In addition, evidence for further high-mass structure was seen. (auth)

59319 LIMITING DISTRIBUTIONS FOR TARGET FRAGMENTATION IN THE REACTIONS $\pi^\pm + p \rightarrow \pi^- +$ ANYTHING. Shephard, W. D. (Univ. of Notre Dame, Ind.); Powers, J. T.; Biswas, N. N.; (and others). Contract AT(11-1)-881. Phys. Rev. Lett.; 27: No. 17, 1164-7(25 Oct 1971).

The inclusive reactions $\pi^- + p \rightarrow \pi^- +$ anything at 8, 18.5, and 24.8 GeV/c and $\pi^+ + p \rightarrow \pi^- +$ anything at 18.5 GeV/c were studied. Distributions of the particle density $\omega(d\sigma/dp_{||})/(\sigma_T)_\infty$ at $p_{||} \lesssim 1$ GeV/c for the "inclusive" π^- indicate an approach to limiting behavior for π^+p at current accelerator energies. Invariant cross sections for π^-p decrease significantly in magnitude as the incident energy increases. The decrease is consistent with an energy dependence similar to the form $A + Bs^{-1/2}$ suggested by Regge phenomenology, with the π^-p distribution approaching the π^+p limiting distribution as a limit. (auth)

59320 EXPERIMENTAL STUDY OF ω NEUTRAL DECAYS. Datin, J. T.; Hauser, M. G.; Kreisler, M. N.; Mischke, R. E.; Ritsko, J. J. (Princeton Univ., N. J.). Contract AT(30-1)-4159. Phys. Lett.; 36B: No. 6, 607-10(18 Oct 1971).

The neutral branching ratios of the ω meson were determined by measuring the c.m. momentum spectrum of single γ's from ω decay. The sample of 400 ω events after background subtraction yields an upper limit of $(\omega \rightarrow \eta\gamma)/(\omega \rightarrow \text{neutrals}) < 25\%$ (90% confidence). The fit with $\omega \rightarrow \pi^0\gamma$ only cannot be excluded. However, the best fit is obtained with the ratios $(\omega \rightarrow \pi^0\gamma)/(\omega \rightarrow \text{neutrals}) = (78 \pm 7)\%$ and $(\omega \rightarrow \pi^0\pi^0\gamma)/(\omega \rightarrow \text{neutrals}) = (22 \pm 7)\%$. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 59580 and 59846.

59321 (JINR-E2-5993) TRANSFORMATION PROPERTIES OF STATES AT INFINITE MOMENTUM II. Robaschik, D.; Smorodinskii, Ya. A.; Wieczorek, E. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 13p. Dep. NTIS (U. S. Sales Only).

The well known result, that helicity states of massive particles at infinite momentum satisfy the same transformation laws as the states of massless particles, is extended to the states with $p^2 < 0$. In the cases $p^2 > 0$ and $p^2 < 0$ canonical states are defined. The asymptotic properties of the Wigner rotation for these states are considered. A connection is given between the Wigner rotation in the infinite momentum limit and the rotation in the corresponding subspace induced by the transformation of an appropriate light-like vector. (auth)

59322 (NP-19024) REMARKS ON INCLUSIVE EXPERIMENTS AND HIGH ENERGY MODELS. Note No. 310. Boldrighini, C.; Lusanna, L.; Sertorio, L. (Rome Univ. (Italy). Istituto di Fisica). 2 Apr 1971. 12p. Dep. NTIS (U. S. Sales Only).

The models discussed are the multiperipheral, multi-Regge, and dual. The average multiplicity and average perpendicular momentum for the high-energy interactions are intimately connected with each other in the models considered and also connected to the asymptotic behavior of the absorptive part of the elastic amplitude. These connections are discussed. (J.F.P.)

59323 RECENT PROGRESS IN CURRENT ALGEBRA. Fubini, S. (Univ., Turin). pp 401-14 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

59324 ALGEBRA OF FIELDS. Lee, T. D. (Columbia Univ., New York). pp 415-20 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

59325 MOTION OF A PARTICLE IN A REFRACTING MEDIUM. de Broglie, Louis Compt. Rend., Ser. B; 272: No. 24, 1333-5(14 Jun 1971). (In French).

A dynamic problem with variable rest mass is studied in the framework of the double solution theory. The particle considered moves in a refracting and possibly dispersing medium. (France)

59326 EXCITING WORLD OF HADRON PHYSICS. Squires, E. J. (Durham Univ., Eng.). Phys. Bull. (London); 22: 517-20 (Sep 1971).

The world of hadron physics consists of a large body of complex experimental information, some of which shows surprisingly simple patterns and regularities but essentially none of it is understood. Most theoretical work consists in finding clever ways of presenting the data and explanations are, in general, lacking. Questions raised by the experimentalists work are considered, such as: What dominates high energy scattering or what is the pomeron? Do Regge poles factorize? Where are baryon parity doublets? Where are the zeros of scattering amplitudes and why? Why are mesons and baryons so different? These may not be the most fundamental questions but those for which it is hoped answers will be found in the near future. (UK)

59327 ANGULAR DISTRIBUTION OF PARTICLES PRODUCED IN MULTIPLE PROCESSES. Daibog, E. I.; Rozental, I. L. (Inst. of Cosmic Research, Moscow). Yadern. Fiz.; 14: No. 1, 226-31(Jul 1971). (In Russian).

General reasons for the two-bump structure of the distributions in logarithmic coordinates are considered. It is shown that in the c.m. frame the two-bump structure is present at sufficiently high primary energy and practically at every total momentum distribution. Preservation of the two-bump structure in the lab. frame depends on the relative content of the nonrelativistic particles in the showers. General conditions for the presence of the two-bump structure in the lab. frame are established for a large class of distributions on the total momentum. The experimental presence of a small (~20%) amount of the "two-bump" events is explained as the result of fluctuations of the portion of slow particles. (auth)

59328 POLARIZATION PROPERTIES OF PARTICLES PRODUCED AT HIGH ENERGIES. Karnakov, B. M. (Moscow Engineering-Physics Inst.). Yadern. Fiz.; 14: No. 2, 454-7 (Aug 1971). (In Russian).

It is noted that if the high-energy asymptotics of a process $a + b \rightarrow A + B$ is dominated by a single boson Regge pole and when the polarization state of a particle a (or b) is "pure" (i.e., $\rho^2_{a(b)} = \rho_{a(b)}$), the spin state of the particle A (or B) is also "pure." Deviation of $\rho^2_{A(B)}$ from $\rho_{A(B)}$ indicates a presence of several Regge poles or the j-plane branch points. The case of partial polarization of the colliding particles is discussed. (auth)

59329 VIOLATION OF THE POMERANCHUK-THEOREM CONDITIONS AND THE ODD-SIGNATURE AMPLITUDE. Fukuda, R. (Tokyo Univ.). Phys. Rev., D; 4: No. 3, 830-3(1 Aug 1971).

The properties of the odd-signature amplitude are discussed in the case that the total cross sections of the particle and antiparticle tend to constant but different limits at high energy. The imaginary and real part of the odd-signature amplitude must be correlated by a simple relation and also be subjected to various stringent conditions. Sum rules are obtained that can be used as a test of the violation of the Pomeranchuk theorem. A specific model is proposed satisfying these conditions, and some consequences are discussed. (auth)

59330 EIKONAL APPROXIMATION FOR INELASTIC PROCESSES. Harrington, David R. (Rutgers-The State Univ., New Brunswick, N. J.). Phys. Rev., D; 4: No. 3, 840-8(1 Aug 1971).

The eikonal approximation for the contributions to inelastic scattering from arbitrarily crossed ladder graphs is considered. The particle represented by one of the "sidepieces" of the ladders is allowed to change its state and mass at each rung; the other sidepiece particle is restricted to have at most one change of state, and that only if its elastic interactions are the same in the two states. When the denominators of the latter sidepiece can be linearized, the amplitudes reduce to forms essentially identical to those found in nonrelativistic coupled-channel potential theory. This result is independent of the ratio of the energy to the sidepiece mass and connects smoothly the nonrelativistic and extreme relativistic regimes. Its implications for absorptive models are discussed briefly. (auth)

59331 SUM RULES FOR INCLUSIVE CROSS SECTIONS. DeTar, C. E.; Freedman, D. Z.; Veneziano, G. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 4: No. 3, 906-9 (1 Aug 1971).

In generalization of known results, rigorous sum rules are presented for inclusive cross sections based upon conservation of momentum or of any additive discrete quantum number. Included are formulas which normalize inclusive cross sections in terms of σ_{total} independently of multiplicities. The sum rules could be useful in constraining theoretical models which construct inclusive cross sections without detailed reference to exclusive processes. Some applications are described and a generalization to the tensors governing weak and electromagnetic inclusive reactions is given. (auth)

59332 FEYNMAN'S RELATION FOR PARTICLE PRODUCTION NEAR THE BOUNDARY OF PHASE SPACE. Elitzur, Moshe (Rockefeller Univ., New York). Phys. Rev., D; 4: No. 3, 910-12(1 Aug 1971).

Feynman's relation for one-particle inclusive experiments at the edge of the fragmentation region is derived using only quasi-two-body amplitudes and single-Regge-pole exchange. A similar relation for two-particle inclusive experiments is also derived. (auth)

Electromagnetic

Refer also to abstracts 59228, 59542, and 59573.

59333 (JINR-E2-6036) DEEP INELASTIC ELECTROPRODUCTION OF HADRONS ON A PHOTON TARGET. Kunszt, Z.; Ter-Antonyan, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 13p. Dep. NTIS (U. S. Sales Only).

The inelastic scattering ee → eeN hadrons, on the condition that one of the final state electrons is detected at large angles, is discussed. A simple estimate shows that this process may make possible the observation of the deep inelastic electroproduction of hadrons on a photon target. (auth)

59334 (LNF-71/14) OBSERVATIONS ON THE PRODUCTION OF HADRONS BY MEANS OF THE LANDAU-LIFSHITZ PROCESS. Parisi, G.; Testa, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 31 Mar 1971. 5p. (In Italian). Dep. NTIS (U. S. Sales Only).

The cross section for the production of hadrons is calculated on the assumption that part of the hadron processes observed with crossed e^+e^- beams result from the interaction of the electromagnetic fields created by the electrons and positrons. (J.S.R.)

59335 TAMAGAKI AND HAMADA-JOHNSTON POTENTIALS AND ELASTIC ELECTRON-DEUTERON SCATTERING. Pask, Colin (Univ. of South Wales, Kensington, Australia). Progr. Theor. Phys. (Kyoto); 46: No. 1, 336-8(Jul 1971).

A comparison is made between the Tamagaki and Hamada-Johnston potentials by examining elastic electron-deuteron scattering results. It is found that the calculations show differences between the two potentials, but the differences only become significant when the nonrelativistic model used begins to break down. It is concluded that the method used does not lead to a clear unambiguous result. (L.B.S.)

59336 MONOCHROMATIC RADIATION FROM A COHERENT MODULATED BEAM OF CHARGED PARTICLES. Favro, L. D.; Fradkin, D. M.; Kuo, P. K. (Wayne State Univ., Detroit). Phys. Rev. Lett.; 25: 202-4(27 Jul 1970).

It is suggested that intense laser fields may be used to modulate the wave functions of electrons. A classical model is used to demonstrate the greatly altered radiation fields of these electrons after they emerge from the laser beam. The observation by Schwarz and Hora of visible radiation from a nonluminescent target appears to result from these fields. (auth)

59337 RELATIVISTIC MODEL FOR THE ELECTRO- AND WEAK PRODUCTION OF NUCLEON RESONANCES. Zucker, Paul Alan. Stanford, Calif.; Stanford Univ. (1971). 210p. University Microfilms Order No. 71-19,786.
Thesis.

A model was developed to describe the electro- and weak production of nucleon resonances off of nucleon targets. The helicity amplitudes which describe these processes are calculated in the model by choosing a covariant and gauge-invariant (a partially conserved axial current is used for the weak case) set of exchange graphs thought to play an important role as an excitation mechanism. The projection of the exchange graphs into the partial wave channel under consideration is then multiplied by a final-state enhancement factor which provides a resonance mechanism. It is shown how this model incorporates unitarity as an approximate solution to the Omnès equation and how it also obeys the threshold, covariance, and analyticity requirements of the processes in question. Since one is primarily interested in the resonances at energies above 1236 MeV, one is forced to confront the problem of inelastic hadronic scattering. The procedure is then to perform a coupled-channel calculation keeping the $|\pi N\rangle$ and $|\pi N^*(1236)\rangle$ channels as intermediate states and assume that one hadronic eigenphase shift is resonant. The final-state enhancement factor is then determined in terms of an integral over the eigenphase shift. As input, the experimentally determined phase shifts for pion-nucleon scattering are used. The π,N, and vector meson exchange is kept as the excitation mechanism and some N*(1236) exchange is included as well. For the elastic form factors the known values are used and the model then predicts the inelastic form factors for resonance excitation. Also the widths and locations of the resonances as they are observed in electro- or weak production are predicted. The electroproduction predictions are compared with the subsequent experimental results from SLAC and are found to agree out to large values (~5 GeV^2) of k^2, the square of the four-momentum transferred from the leptons. For all four observed resonant peaks it was predicted that the ratio of the inelastic to elastic cross sections rises and then levels off abruptly at small k^2, remaining constant out to large k^2. The extent of this rise (typically one or two decades in the SLAC experiments) and the region where the ratio levels off are predictions which are particularly model dependent. It is also predicted that the spin ½ resonances are unimportant in electroproduction, based on their small observed contribution to photoproduction. Interestingly, a one-channel model, keeping only the $|\pi N\rangle$ intermediate state, worked well for the integrated electroproduction cross sections (but it gave predictions for the individual inelastic form factors noticeably different from those of the two-channel calculation). In predicting the integrated weak production cross sections (related experiments are being planned, for example, at Brookhaven and at the National Accelerator Laboratory), this simpler one-channel calculation was used. For this process an explicitly conserved vector current and partially conserved axial current were kept, and the results obey the forward lepton theorem when the scattering angle is zero. (Diss. Abstr.)

59338 CLASSICAL CHARGE SYMMETRIC THEORY OF THE PHOTOPRODUCTION OF SCALAR MESONS. Rosenblum, Arnold. Philadelphia; Temple Univ. (1971). 103p. University Microfilms Order No. 71-19,965.
Thesis.

The cross section for the photoproduction of scalar mesons is calculated on the basis of a classical charge-symmetric field theory. The form of the equations of motion of singularities of the nonlinear fields was determined exactly. The fields appearing in the equations of motion must be evaluated at the position of the nucleon. To do this, the nonlinear field equations which take into account the interaction between the meson and electromagnetic fields were solved in first order by a method of successive approximation based on expanding all field quantities in powers of the coupling constant e. The fields were evaluated at the nucleon position by making use of the method of Riesz potentials. The equations describing the motion of the particle in four space and of its isotopic spin in "charge space" were solved by assuming slow motion and small oscillations both for the actual motion of the nucleon and for the motion of the isotopic spin vector. It was found that the cross sections for the interacting case then reduce to the same result as in the noninteracting case. Incidental to these calculations, it is also found that in action-at-a-distance theory the cross sections in the interacting case are the same as the noninteracting ones and different from those of field theory. All results are shown to be consistent with the principle of detailed balance by consideration of the inverse processes. (Diss. Abstr.)

59339 NUCLEON FORM FACTOR AT HIGH ENERGIES. Ruck, H. M. Stud. Univ. Babes-Bolyai, Ser. Phys.; 16: No. 1, 25-7(1971).

The high-energy behavior of the nucleon form factor was studied by Jaffe (Phys. Rev. Lett. 17, 661(1966)) under the assumptions that the nucleon field is of type S and the momentum distribution of the nucleon field has a mass-gap. It is shown that in the final stage of the calculations a different procedure may be used following the theorem of Phragmen-Lindelof on regular functions. (L.B.S.)

59340 COMPTON SCATTERING AT HIGH ENERGIES. Shibasaki, Ichiro (Tokyo Univ.); Minamikawa, Toshiyuki; Watanabe, Tsunetoshi. Progr. Theor. Phys. (Kyoto); 46: No. 1, 173-89(Jul 1971).

Using the continuous moment sum rule it is found that the third vacuum pole P'' is important for the forward proton Compton scattering, and the residue of the fixed pole at $J = 0$ is also estimated. The third vacuum pole P'' has zero intercept $\alpha_{P''}(0) \cong -0.5$. The prediction of the high energy total cross section is consistent with recent experimental results. (auth)

59341 ON THE POSSIBILITY OF PRODUCING 0.1-GeV IONS BY FOCUSING ULTRASHORT LASER PULSES ON THIN FOILS. Caruso, A.; Gratton, R. (European Space Research Inst., Frascati, Italy). Phys. Lett.; 36A: No. 4, 275-6(13 Sep 1971).

The possibility of creating a high-energy neutralized ion beam (energy ≈ 1 MeV per nucleon), by a laser pulse, is considered. (auth)

59342 SOME CONSEQUENCES OF THE ASYMPTOTIC SCALING ASSUMPTION. Boiti, M.; Donini, E.; Pempinelli, F. (Univ., Lecce, Italy). Lett. Nuovo Cim.; 2: No. 14, 686-8(2 Oct 1971).

It is shown that the asymptotic scaling assumption for the structure functions νW_2 and W_1 of the electron-proton scattering process giving electron and hadrons constrains the longitudinal scaling amplitude for this process to be identically zero. (L.B.S.)

59343 ELECTROMAGNETIC INTERACTIONS OF COSMIC-RAY MUONS AT LARGE ZENITH ANGLES AT SEA LEVEL. Ashton, F.; Coats, R. B. (Univ. of Durham, Eng.). J. Phys., A (London); 4: No. 5, 649-59(Sep 1971).

The electromagnetic interactions of cosmic-ray muons incident at sea level in the zenith angle range 50 to 90° were studied. The measurements cover energy transfers from 3 to 240 GeV produced by muons in the energy range 34 to 520 GeV. No significant divergence from accepted theory was found. (auth)

59344 QUARK–MOLECULE CALCULATIONS. Goto, Eiichi (Tokyo Univ.); Matsuoka, Osamu; Kunii, Tosiyasu L. Phys. Rev., A; 4: No. 4, 1380-7(Oct 1971).

Electronic structures of hypothetical molecules containing quarks, or fractionally charged particles, are treated. By regarding the quark charge Q as a continuous variable, approximations satisfying a consistency condition at small-Q values are formulated. Their validity is checked with the exact solutions of the one-electron two-center problem and applied to two-electron two-center problems of H^--quark and He-quark molecules. (auth)

59345 QUANTUM-ELECTRODYNAMIC MODEL FOR PRODUCTION AMPLITUDES AT INFINITE MOMENTUM. Pardee, William Joseph. Urbana, Ill.; Univ. of Urbana (1971). 101p. University Microfilms Order No. 71-21,202.

Thesis.

The scattering amplitude for the production of an arbitrary number of electron-positron pairs in electron–electron collisions is calculated in an infinite momentum field theory model. More precisely, the model considers only events where the center of momentum energy is much larger than typical subenergies between pairs which are adjacent in longitudinal momentum. The subenergies are assumed much larger than masses and momentum transfers. The calculation is restricted to multiperipheral diagrams. In an approximation that neglects electron and photon masses, it is possible to obtain a simple form for the sum of all the partial cross sections generated by these diagrams. The number distribution P(n), the average number of pairs produced, the two particle and one particle momentum distributions and the total cross section are obtained. The two particle distribution is expressed in terms of the invariant mass, total longitudinal momentum, and transverse momenta of the pair. The contribution of these processes to the absorptive part of the elastic amplitude is studied for small t. (Diss. Abstr. Int., B)

59346 ELECTROPRODUCTION OF π^0: A CRUCIAL TEST OF DIP MECHANISMS. Harari, Haim (Stanford Univ., Calif.). Phys. Rev. Lett.; 27: No. 15, 1028-31(11 Oct 1971).

Dips in differential cross sections of inelastic hadronic reactions may be caused by nonsense zeros or by geometrical effects. A direct way of resolving this question is to change the interaction radius in a reaction, while keeping all other parameters fixed, and to see whether the dips move. The "radius" of a virtual spacelike photon has been predicted to change with its mass. If this is verified (e.g., in ρ^0 electroproduction), a study of the dip in π^0 electroproduction should decide between the two schools of dip mechanisms. (auth)

59347 IMPOSSIBILITY OF REDUCTION OF ELECTROMAGNETIC FIELDS IN FREE SPACE FOR NONZERO-MASS SYSTEM. Rajput, B. S. (Kurukshetra Univ., India). Lett. Nuovo Cim.; 2: No. 14, 712-14(2 Oct 1971).

It is shown that for nonzero-mass systems it is not possible to reduce the electromagnetic fields which satisfy Maxwell's equations without sources. The reduction is possible only either in the presence of charge-source or current-source or of both. (L.B.S.)

59348 RHO–OMEGA INTERFERENCE AND THE PHASE OF THE RHO-PROPAGATOR. Allcock, G. R.; Whipp, A. T. (Univ. of Liverpool). Lett. Nuovo Cim.; 2: No. 14, 719-23 (2 Oct 1971).

In order to reconcile recent observations of $\rho-\omega$ interference in the leptonic and hadronic decay modes from photoproduction processes, it is suggested that the pole in the ρ-propagator has a complex residue, that the residue is far from being real, and has a phase of about $-100°$. (L.B.S.)

59349 ON THE EXACT PROPAGATOR. Jones, A. V.; Papadopoulos, G. J. (Univ. of Leeds, Eng.). J. Phys., A (London); 4: No. 5, L86-9(Sep 1971).

The propagator is evaluated for an electron subject to a harmonic force, a constant magnetic field and a time prescribed electric field, exactly. However, the primary concern is to draw attention to important works in the literature that have been overlooked, a result of which has brought some duplication without always corresponding methodological improvement. (auth)

59350 ELECTROMAGNETIC WAVE TAILS IN THE SECOND APPROXIMATION TO THE EINSTEIN–MAXWELL EQUATIONS. Rotenberg, M. A. J. Phys., A (London); 4: No. 5, 617-31(Sep 1971).

With a finite oscillating linear coherent distribution of electric charge chosen as the source of electromagnetic radiation, it is shown that the outgoing multipole electromagnetic waves of the linear approximation to the Einstein–Maxwell equations produce wave tails in the second approximation which, after the end of the source vibration, constitute incoming multipole waves. (auth)

59351 VECTOR MESON DOMINANCE AND PION PHOTOPRODUCTION. Potter, Wendy Nan Torrance. Urbana, Ill.; Univ. of Illinois (1971). 110p. University Microfilms Order No. 71-21,214.

Thesis.

A detailed theoretical treatment is given of the vector meson dominance approximation of a k^2 dispersion relation for any of a large number of sets of invariant amplitudes for pion photoproduction. The resulting cross section always has a kinematic singularity; whether or not it is in the physical region depends on which set is used. The standard proportionality between polarized photon and vector meson cross sections in the center of mass is recovered at high s for some of the sets discussed. Support for vector meson pole dominance of a k^2 dispersion relation at high s is found from the investigation of the analyticity of the box graph as a function of the mass-squared of one of the external particles. A question is raised concerning the renormalization of divergent diagrams containing a single vector meson virtual state in the familiar Lagrangian treatment of vector meson dominance. (Diss. Abstr.)

59352 VENEZIANO-TYPE REPRESENTATIONS OF THE PION FORM FACTOR AND COUPLINGS OF PHOTONS TO HEAVY VECTOR MESONS. Cleymans, J.; Rodenberg, R. (Technische Hochschule, Aachen). Nuovo Cim.; 5A: No. 2, 297-304(21 Sep 1971).

Consequences of Veneziano-type representations for the pion form factor are considered. It is found that a simultaneous fit to the asymptotic behavior and to the couplings of photons to vector mesons is not possible without adding satellite terms. The smallness of the derived couplings of higher vector mesons is shown to be related to the small observed deviation from ρ universality. (auth)

59353 ELECTROPRODUCTION OF π^0-MESONS ON PROTONS IN THE BACKWARD DIRECTION. Driver, C. (DESY, Hamburg); Heinloth, K.; Hoehne, K.; (and others). Nucl. Phys.; B33: No. 1, 84-100(1971).

Electroproduction of π^0-mesons on protons at backward angles was investigated by measuring the scattered electron and the recoiling proton in coincidence. The differential cross section was determined as a function of W, q^2, $\theta_{\pi^0}^{cms}$ and u. (auth)

59354 WIDE ANGLE SCATTERING IN QUANTUM ELECTRODYNAMICS. Cardy, J. L. (Cambridge Univ., Eng.). Nucl. Phys.; B33: No. 1, 139-51(1971).

High energy elastic electron-electron scattering at wide angles is studied in quantum electrodynamics. The amplitude is predicted to decrease exponentially with increasing energy, in agreement with strong interaction data. (auth)

59355 ELECTROPRODUCTION OF PIONS ON NUCLEI IN BOUND STATES. Dmitriev, V. F. (Inst. of Nuclear Physics, Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.); 14: No. 2, 81-3(20 Jul 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 2, 124-7(20 Jul 1971).

An experimental study of electroproduction of a pion immediately in the bound state of a mesic atom is proposed to obtain information on the s-levels of mesic atoms with large Z. The cross section for this process is calculated for ^{12}C, ^{20}Ne, and ^{35}Cl. (L.B.S.)

59356 AXIAL-VECTOR FORM FACTORS FROM CURRENT ALGEBRA REGGE POLES AND VENEZIANO MODEL. Dominguez, C. A.; Zandron, O. (Univ., Buenos Aires). Nucl. Phys.; B33: No. 1, 303-16(1971).

Considering the following processes axial current + nucleon → vector current + nucleon, and axial current + pion → vector current + σ-meson, and making use of current algebra identities and the Regge model, an asymptotic expression is obtained for the axial-vector form factors of the nucleon and the pion. Though no definite power behavior can be found by means of the Regge model alone, it is possible to find, under suitable assumptions, generalized scaling relations among vector and axial vector form factors. The use of the Veneziano model in the pion case, fixes the asymptotic power behavior and thus, the pion scaling relations are obtained without further assumptions. (auth)

59357 POSSIBLE CONNECTION BETWEEN THE AMPLITUDES OF THE PROCESSES $e^+e^- \to 3\pi$, $\gamma\gamma \to 3\pi$, AND $\pi^0 \to 2\gamma$.

XUM

Terent'ev, M. V. JETP Lett. (USSR) (Engl. Transl.); 14: No. 2, 94-6(20 Jul 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 2, 140-3(20 Jul 1971).

The matrix elements of the processes $e^+e^- \rightarrow 3\pi$ and $\pi^0 \rightarrow 2\gamma$ are examined and the parameters obtained are related to the amplitude for $\gamma\gamma \rightarrow 3\pi$. (L.B.S.)

59358 POSSIBILITY OF OBSERVING QUASINUCLEAR MESON RESONANCES IN COLLIDING e^+e^- BEAMS. **Dal'karov, O. D.; Mandel'tsveig, V. B.; Khoze, V. A. JETP Lett. (USSR) (Engl. Transl.); 14: No. 2, 87-9(20 Jul 1971).**

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 2, 131-4(20 Jul 1971).

The mechanism for production of S(1727), S(1414), d(1855), and d(1382) quasinuclear meson resonances, corresponding to bound states of the $N\bar{N}$ system, from e^+e^- colliding-beam interactions is considered. It is pointed out that a correspondence should occur between the partial widths of the decays of the resonance and the cross sections for the annihilation in the same states. It is concluded that the colliding-beam experiment makes it possible to observe quasinuclear meson resonances, and also to obtain considerable information on the behavior of the electromagnetic form factors of the nucleon in the time-like region and concerning the mechanism of multiparticle production of pions. (L.B.S.)

59359 SYNCHROTRON MOTION WITH RADIATION REACTION. **Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Int. J. Theor. Phys.; 4: No. 5, 389-94(Sep 1971).**

It is shown that the longitudinal velocity of a charged particle moving in a uniform magnetic field, and obeying Dirac–Lorentz relativistic equation of motion with radiation reaction is constant. Suitable approximate methods, which give fairly accurate results, are used to obtain the expression for velocity and displacement along the transverse section. They describe the motion completely up to a correcting factor $1 + 0\{(e^3B/m^2c^4)^2\}$; $(e^3B/m^2c^4) \simeq 10^{-16}$ B for electrons, B in G. (auth)

59360 ALGORITHMS FOR THE γ-ALGEBRA OF ELECTROMAGNETIC FORM FACTORS. **Chisholm, J. S. R. (Univ. of Kent, Canterbury, Eng.). J. Comput. Phys.; 8: No. 1, 1-18(Aug 1971).**

The γ-algebra arising in the calculation of contributions from any allowable vertex part to the electromagnetic form factors is considered. Simple algorithms are established which enable any form factor contribution to be written down as a function of Chebyshev polynomials whose argument is $P = 2 - q^2$, where q is the photon 4-momentum. These algorithms are particularly suitable for use in computer programs for evaluating high-order vertex parts in perturbation theory. (auth)

59361 LARGE DEVIATIONS FROM THE SCALING LAW FOR THE PROTON FORM FACTOR IN THE TIMELIKE REGION. **Pfister, H. (Univ., Tuebingen, Ger.). Nucl. Phys.; B22: No. 1, 327-32(1970).**

Analytic continuation of the proton form factors G_M and G_E into the time-like region shows—independent of the special extrapolation technique—severe violations of the scaling law $G_E = G_M/\mu$, and favors the relation $G_E = G_M$ at the threshold for the process $e^+e^- \rightarrow p\bar{p}$. (auth)

59362 REMARKS ON PION PHOTOPRODUCTION. **Jackson, J. D.; Quigg, C. (Univ. of California, Berkeley). Nucl. Phys.; B22: No. 1, 301-16(1970).**

Some predictions for charged pion photoproduction implicit in a previous work are presented. These include extension of the pseudomodel to somewhat larger t-values and a discussion of photoproduction from a polarized target. Some remarks are also made on the predictions of gauge-invariant perturbation theory. (auth)

59363 DOES DUALITY HOLD IN CURRENT INTERACTIONS? Ezawa, Zyun F. (Tokyo Univ.). Phys. Rev. Lett.; 27: No. 16, 1092-5(18 Oct 1971).

Deep-inelastic electron-proton scattering is shown to be naturally interpreted in a field theory where the current is given by a bilinear form in some fields. It is proved that in such a theory the Compton-scattering amplitude is not saturated with the vector-dominance model and that the term which scales in the Bjorken limit does not obey Freund–Harari duality. (auth)

59364 PHOTOPRODUCTION OF e^+e^-, $\rho-\omega$ MIXING AND VECTOR DOMINANCE. Quinn, H. R.; Walsh, T. F. (Deutsches Elektronen-Synchrotron, Hamburg). Nucl. Phys.; B22: No. 2, 637-50(1970).

The $\rho-\omega$ mixing is discussed, in particular with respect to its possible effect on the invariant-mass spectrum of electron-positron pairs photoproduced off a nuclear target. It is found that with the order of magnitude of the mixing indicated by recent experiments, observing it in other processes would yield a significant effect on the e^+e^- photoproduction. The necessity for a consistent analysis of all channels in evaluating the mixing effect is emphasized. (auth)

59365 VECTOR-MESON DOMINANCE MODEL AND INELASTIC ELECTRON–PROTON SCATTERING. **Sullivan, J. D. (Weizmann Inst. of Science, Rehovoth, Israel. Univ. of Illinois, Urbana). Nucl. Phys.; B22: No. 2, 358-64(1970).**

The ambiguities of the vector-dominance model as applied to inelastic electron–proton scattering are discussed. The region $s \gg |q^2|$ seems to be the only region in which the model could, even in principle, be meaningful. The region closest to the pole, namely $q^2 \approx 0$, is of primary significance for testing the model. (auth)

59366 RADIATIVE CORRECTIONS TO INELASTIC e^-p SCATTERING. **Mackouse, E. M.; Schwarz, F. F. (Univ. of Texas, Austin). Nucl. Phys.; B22: No. 2, 423-8(1970).**

It is shown that the so called peaking approximation used in making radiative corrections is not applicable for inelastic e^-p scattering when the energy of the incoming electron is very high, in fact it is shown, that none of the formulas usually used for performing the radiative corrections to inelastic e^-p scattering is the result of a peaking approximation. The reason for the failure of the peaking approximation is explained and a method to improve the accuracy of the radiative corrections is proposed. (auth)

59367 EFFECT OF BARYON RESONANCE ADMIXTURES ON ELASTIC ELECTRON DEUTERON SCATTERING. **Williams, H. T.** (Univ., Erlangen, Ger.); **Arenhovel, H.; Miller, H. G.** Phys. Lett.; 36B: No. 4, 278-80(20 Sep 1971).

The deuteron form factors for elastic e-d scattering were calculated with the inclusion of baryon resonance admixtures in the deuteron wave function in the range $0.1 \leq q^2 \leq 50\ \mathrm{fm}^{-2}$ of the squared four momentum transfer. The inclusion of the resonance configurations leads to an increase of about 10% in the charge and of about 20 to 30% in the enhancement dipole form factor for $10 \leq q^2 \leq 20\ \mathrm{fm}^{-2}$. This enhancement stems mainly from the $\Delta(1236)-\Delta(1236)$ configuration. These findings seem to be consistent with recent experimental results. (auth)

59368 COMPTON EFFECT AND INDUCED COMPTON EFFECT IN CONSTANT ELECTROMAGNETIC FIELD. **Zhukovskii, V. Ch.; Kherrmann, I. (Moscow State Univ.). Yadern. Fiz.; 14: No. 1, 150-9(Jul 1971). (In Russian).**

The spectral and angular distribution for the Compton effect in a constant electromagnetic field is obtained. The possibility of existence of the induced Compton effect in the external field is proved, i.e., the emission of two photons, one of which is induced by the incident electromagnetic wave. In case of constant magnetic field, the deviation of the distribution obtained for the Compton effect from the Klein–Nishina formula as well as the behavior of the distribution for the induced Compton effect are discussed. The optimal region is shown where the observation of these effects is possible. (auth)

59369 BREMSSTRAHLUNG IN THE BACKWARD e^+e^- SCATTERING AS A MULTI-REGGE PROCESS. **Lipatov, L. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 14: No. 1, 160-77(Jul 1971). (In Russian).**

It is shown that formulas for bremsstrahlung amplitudes in backward e^+e^- scattering at high energies $\sqrt{s} \gg m$ previously found permit a simple interpretation in terms of partial waves, $f_{l_1,l_2,\ldots,l_{n+1}}$, in the corresponding crossing channels. These partial waves have an infinite number of Regge poles whose residues are factorizable. The writing of the bremsstrahlung amplitudes as an expansion in the partial waves $f_{l_1\ldots l_{n+1}}$ makes it possible to construct an integral equation for the e^+e^- backward scattering cross section with the emission of an arbitrary number of γ quanta. (auth)

59370 TWO-PHOTON GENERATION MECHANISM IN THE COLLISION OF CHARGED PARTICLES. **Terent'ev, M. V. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 1, 178-89(Jul 1971). (In Russian).**

A simple invariant method is given for calculation with logarithmic accuracy the production cross section asymptotics for a fixed effective mass value of the produced particles. The two-photon generation mechanism is considered. The main result is contained in the given formulas. A number of concrete examples are considered. A number of angular distributions are discussed and concrete estimates for the π^0-meson production reactions are given. (auth)

59371 DEEP INELASTIC HADRON PRODUCTION IN COLLIDING LEPTON BEAMS. **Choban, E. A.; Shekhter, V. M. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 14: No. 1, 190-202(Jul 1971). (In Russian).**

Hadron production in colliding lepton beams is considered. The hadron state may be C-even or C-odd. In the first case the hadrons are produced by one virtual photon, in the second case they are produced by two photons. It is assumed that the process is deep inelastic, i.e., the photon virtual masses are large. Explicit expressions for the differential cross sections are obtained in two kinematical regions. In the first region the virtual masses of both the photons are of the same order of magnitude as the c.m. total energy, however, all the quantities are small compared with the colliding lepton energy. In the second region only one virtual mass has the order of the total energy and both the quantities may be near to the lepton energy; the mass of the second photon is assumed to be rather small. The differential cross section of the process ee → ee + hadrons is expressed in terms of the total cross sections of processes $e^-e^+ \to$ hadrons and $\gamma\gamma \to$ hadrons, allowing one in principle, to investigate the cross sections in the deep inelastic region. (auth)

59372 ELECTROMAGNETIC CORRECTIONS TO HIGH-ENERGY ELECTRON–HADRON SCATTERING. **Frankfurt, L. L. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 14: No. 1, 203-10(Jul 1971). (In Russian).**

It is shown that at high energies, in a number of cases interesting in view of experiment, the contribution from radiational corrections to the electron–hadron scattering is suppressed. At low momentum transfers the two-photon-exchange contribution to the elastic $e^{\pm}N$ scattering is expressed in terms of the Compton scattering cross section known from the experiments on the electroproduction on proton (neutron). (auth)

59373 S-WAVE THRESHOLD AMPLITUDES OF NEUTRAL PION PHOTOPRODUCTION ON NUCLEONS AND THE PCAC HYPOTHESIS. **Govorkov, B. B.; Minarik, E. V. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 14: No. 2, 437-40 (Aug 1971). (In Russian).**

Experimental determination of the threshold amplitudes of the neutral pion photoproduction on nucleons $E_{0+}(p\pi^0)$ and $E_{0+}(n\pi^0)$ is analyzed. The experimental results are compared with the calculations corresponding to the PCAC hypothesis. The agreement obtained is treated as important in favor of the hypothesis. (auth)

59374 BREMSSTRAHLUNG IN THE e^+e^- BACKWARD SCATTERING AT HIGH ENERGIES. **Lipatov, L. N. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 14: No. 2, 396-407(Aug 1971). (In Russian).**

The calculation of the bremsstrahlung cross sections for backward scattering in the double-logarithmic approximation is considered by means of the $e^+e^- \to e^+e^- + n\gamma$ scattering amplitudes previously obtained. It is shown that in spite of the cross section of each separate γ quanta emission normalized to the Born cross section of elastic e^+e^- scattering decrease with energy, the emission cross section for an arbitrary number of γ quanta normalized to the same cross section tends to the constant $\simeq 0.8$. (auth)

59375 BREMSSTRAHLUNG HADRON PRODUCTION IN COLLIDING ELECTRON–POSITRON BEAMS. **Altukhov, A. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz.; 14: No. 2, 391-5(Aug 1971). (In Russian).**

An approximate differential cross section is obtained depending on the effective mass of hadrons produced in colliding electron—positron beams by means of the bremsstrahlung mechanism. The obtained expression enables one to estimate the contribution to the total cross section from the whole interval of the hadron effective masses available at the given initial energy. (auth)

59376 POSSIBLE SCALING IN HADRON PRODUCTION IN ee AND e^+e^- COLLISIONS. **Shabel'skii, Yu. M. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 2, 388-90(Aug 1971). (In Russian).**

It is shown that if the scaling is present in the hadron electroproduction, the Regge-pole theory predicts the scaling for the hadron production in ee and e^+e^- collisions. (auth)

59377 PRODUCTION OF NEUTRAL PSEUDOSCALAR MESONS IN REACTIONS $e^+ + e^- \to \pi^0(\eta^0X^0) + \gamma$. **Gakh, G. I. (Ukrainian Physical-Technical Inst., Kharkov). Yadern. Fiz.; 14: No. 2, 382-7(Aug 1971). (In Russian).**

The cross sections of reactions $e^+e^- \to \pi^0(\eta^0X^0) + \gamma$ in the region ω, ρ, and ϕ resonances were calculated using the vector meson dominance model. The cross sections of these reactions were calculated both with and without taking into account the $\eta - X^0$ mixing. The cases of the linear and quadratic mixing of the η and X^0 mesons are considered. The cross sections for reaction $e^+e^- \to \pi^0\gamma$ were calculated using the available upper limit for the $\phi \to \pi^0\gamma$ decay width. (auth)

59378 SCATTERING OF γ QUANTA BY NUCLEONS IN THE QUARK MODEL. Akhiezer, A. I.; Rekalo, M. P. (Physical-Technical Inst., Kharkov). JETP Lett. (USSR) (Engl. Transl.); 14: No. 3, 119-21(5 Aug 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 3, 181-4(5 Aug 1971).

The quark model is extended to the reactions $\gamma + N \to \gamma + N$. The total and differential cross sections for $\gamma + p \to \gamma + p$ and $\gamma + n \to \gamma + n$ interactions are calculated. (J.F.P.)

59379 DEUTERON ELECTROMAGNETIC FORM FACTOR. **Blankenbecler, R.; Gunion, J. F. (Stanford Univ., Calif.). Phys. Rev., D; 4: No. 3, 718-22(1 Aug 1971).**

A vector-mesonic correction to the deuteron form factors is considered which is analogous to the Glauber double-scattering process. This correction dominates the form factors at large momentum transfer. A fit to the static magnetic moment of the deuteron yields a satisfactory fit to the magnetic scattering at large momentum transfer. (auth)

59380 $\Delta I = 1$ MASS DIFFERENCES AND $\eta \to 3\pi$ DECAY. Schechter, J.; Ueda, Y. (Syracuse Univ., N. Y.). Phys. Rev., D; 4: No. 3, 733-42(1 Aug 1971).

The octet baryon $\Delta I = 1$ mass shifts, kaon electromagnetic mass shift, and $\eta \to 3\pi$ decay amplitude are all correlated in the framework of the linear SU(3) σ model. It is shown how this model provides a natural realization of the "tadpole" idea of Coleman and Glashow. An attempt is made to resolve the long-standing mystery associated with the $\eta \to 3\pi$ process, and the rare mode $\eta' \to 3\pi$ is also calculated. Finally, it is shown that the chiral-symmetry-breaking and isospin-nonconserving coefficients in the Lagrangian have the same order of magnitude. (auth)

59381 NONLEADING REGGE BEHAVIOR IN νW_2 AND THE POSSIBILITY OF FIXED POLES WITH POLYNOMIAL RESIDUES. Close, F. E.; Gunion, J. F. (Stanford Univ., Calif.). Phys. Rev., D; 4: No. 3, 742-56(1 Aug 1971).

Some of the theoretical arguments for the existence in Compton scattering of right-signatured fixed poles with polynomial residues are discussed. It is shown that if one could "switch off" the strong interactions, then a fixed pole with residue linear in q^2 (the photon mass squared) would be necessary for the consistency of the fixed-q^2 dispersion relation for νT_2 (whose absorptive part νW_2 is measured in inelastic electroproduction). It is shown that if the above conjecture is correct, then there must be some energy dependence in νW_2 over and above the conventional leading Regge form (Pomeranchukon plus $f - A_2$). Evidence is presented for the presence of such "nonleading behavior" in a similar process. In addition it is shown why the on-shell $\sigma_{tot}(\gamma p)$ could be compatible with the neglect of such a nonleading term. It is found that a fixed pole with polynomial residue and the correct $q^2 \to 0$ Thomson limit can be accommodated by the present data on νW_2 at large q^2. With the above assumptions on the fixed-pole behavior, the high-energy behavior of νW_2 is predicted and it is found that asymptotically it must fall to a value substantially less than its present maximum magnitude. (auth)

59382 HARD-MESON CURRENT-ALGEBRA CALCULATION OF THE $\gamma-3\pi$ AMPLITUDE. Miller, M. G. (Northeastern Univ., Boston). Phys. Rev., D; 4: No. 3, 769-71(1 Aug 1971).

The $\gamma + \pi \to \pi + \pi$ interaction is considered within the context of hard-meson current algebra and a model of PCAC (partially conserved axial-vector current) breakdown previously proposed. The form factor for this process is calculated and the $\gamma-3\pi$ coupling constant evaluated. The results are in agreement with experimental data. (auth)

59383 PRODUCTION OF SINGLE W BOSONS IN ELECTRON–POSITRON COLLIDING BEAMS. **Mikaelian, K. O.; Smith, J. (Univ. of New York, Stony Brook). Phys. Rev., D; 4: No. 3, 785-94(1 Aug 1971).**

The total cross section and angular and energy distributions of poistrons and single W bosons produced in electron–positron colliding beams are computed. The calculation of the total cross section includes all four lowest-order Feynman diagrams contributing to this process. For center-of-mass energies $E < 2M_W$(M_W = boson mass) it is found that the contribution of two of the diagrams is indeed negligible, but the presence of a pole in one of these diagrams invalidates all previous calculations of the total cross section for $E > 2M_W$. Total cross sections are given for three values of the boson's anomalous magnetic moment κ. A rather flat energy distribution of outgoing positrons and a slight peak in the high-energy region of the boson energy distribution are found. The angular distribution of positrons has a very sharp forward peak (in the direction of the initial positrons), while the bosons are distributed mostly in the backward direction. (auth)

59384 PARITY RULE AND HELICITY CONSERVATION IN ρ PHOTOPRODUCTION. Barmawi, M. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 4: No. 3, 861-70(1 Aug 1971).

The parity rule for natural- and unnatural-parity exchange is proved on the basis of the L–S scheme. The parity rule is shown to be a general feature of t-channel exchange processes. Experimental consequences of the parity rule are discussed. The s-channel helicity conservation in ρ^0 photoproduction is considered on the basis of the Regge-pole model with L–S coupling and general arguments from the complex-angular-momentum theory. It is found that the s-channel helicity conservation in ρ^0 photoproduction can be described by the coupling $L = \alpha - 2$, $S = 2$ with a multiplicative fixed pole at the nonsense wrong-signature point $\alpha = 1$. (auth)

59385 ρ-EXCHANGE CONTRIBUTION TO $\gamma n \rightarrow \rho^- p$. Levy, N. (DESY, Hamburg); Glueck, M.; Wagner, S. Phys. Rev., D; 4: No. 3, 874-82(1 Aug 1971).

The process $\gamma n \rightarrow \rho^- p$ is studied in the framework of Born approximation for the ρ exchange with two different procedures for gauge correction. The resulting differential cross section is very sensitive to the value of the magnetic moment of the ρ meson, μ_ρ. Comparison with the experimental results for photon energies $1.4 < E_\gamma < 2.5$ GeV enables an estimate of $\mu_\rho \approx 2\mu_{N_1}$ to be obtained, which, in the light of the necessary refinements of the crude model used here, is regarded as a lower limit. This result is consistent with theoretical predictions of μ_ρ, such as in the $q\bar{q}$ quark model or the $N\bar{N}$ Fermi-Yang model. The calculated density matrix provides a tool to discern the ρ-exchange contribution from the rest. (auth)

59386 HADRON ELECTRODYNAMICS IN THE RESONANCE MODEL: DEEP-INELASTIC e–p SCATTERING, e–e COLLIDING-BEAM PROCESSES, AND OTHER APPLICATIONS. Manassah, Jamal T.; Matsuda, Satoshi (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 4: No. 3, 882-98(1 Aug 1971).

Within the framework of the resonance model, a well-defined gauge-invariant electromagnetic interaction is constructed for the composite hadrons, and the rules are given for the propagator and the current. The formalism is applied to deep-inelastic e–p scattering, and it is found that (a) the structure functions W_1 and νW_2 scale and (b) the theoretical and experimental curves agree remarkably well for $\omega > 1.5$. The photoabsorption cross section is also predicted to within 10% of the experimental value. In the colliding-beam processes, it is found that (a) the structure functions for $e^+ + e^- \rightarrow p +$ "anything" are connected with W_1 and W_2, (b) the cross section for $e^+ + e^- \rightarrow$ "anything" is larger than that for $e^+ + e^- \rightarrow \mu^+ + \mu^-$, and it decreases as s^{-2} for large s, and (c) the hadronic correction for the $ee \rightarrow ee\pi^+\pi^-$ rate is appreciable. Preliminary results are presented on extending the work to include weak interactions, and a structural theorem on the form of the currents is proved. All the results are derived analytically. (auth)

59387 SINGLE PARTICLE ELECTROPRODUCTION AT LARGE Q^2 AND THE ROLE OF WEE PARTONS. Roy, P. (Cornell Univ., Ithaca, N. Y.). Phys. Lett.; 36B: No. 6, 579-85 (18 Oct 1971).

A parton model is presented for single particle electroproductions with large electronic momentum-transfers. Two different asymptotic limits are discussed and related to two kinds of parton-mechanisms. Several testable predictions are made. (auth)

59388 ENERGY OF A TACHYON IN A MAGNETIC FIELD. Huberman, B. A. (Xerox Palo Alto Research Center, Palo Alto, Calif.). Phys. Lett.; 36B: No. 6, 573-4(18 Oct 1971).

The energy levels of a charged tachyon in a magnetic field are obtained and the restrictions imposed on the ground state level for a given magnetic field are discussed. The possibility of observing transitions between these magnetic energy levels is discussed. (auth)

59389 STUDY OF THE VERTICES $\pi^0\gamma\gamma$, $\eta\gamma\gamma$, AND $\eta'\gamma\gamma$ WITH ONE ALMOST REAL AND ONE HIGHLY VIRTUAL PHOTON. Parisi, J. (Univ., Paris); Kessler, P. Lett, Nuovo Cim.; 2: No. 15, 760-3(9 Oct 1971).

The experimental study of the $\pi^0\gamma\gamma$, $\eta\gamma\gamma$, and $\eta'\gamma\gamma$ vertices through collisions of one almost real photon and one highly virtual photon in electron–positron storage rings is suggested. It is shown that the background represented by the double-bremsstrahlung process can be made negligibly small by imposing certain requirements. It is also shown that the cross sections should be large enough to ensure reasonably high counting rates with a colliding-beam machine like DORIS (DESY-Hamberg), presently under construction, of beam energy ~3 GeV and luminosity $\sim(10^{32}-10^{33})$ $cm^{-2}\,s^{-1}$. (L.B.S.)

59390 ANGULAR CORRELATIONS OF THE DECAY PRODUCTS OF TWO HEAVY LEPTONS. Parisi, G. (CNEN, Frascati, Italy); Zirilli, F. Lett. Nuovo Cim.; 2: No. 15, 775-6(9 Oct 1971).

Asymmetry parameters of the decays of heavy leptons $X^\pm \rightarrow \pi^\pm\nu$, $X^\pm \rightarrow K^\pm\nu$, $X^\pm \rightarrow \mu^\pm\bar{\nu}\nu$, and $X^\pm \rightarrow e^\pm\nu\nu$, produced in colliding-beam $e^+ + e^- \rightarrow X^+ X^-$ interactions, are calculated. (L.B.S.)

59391 AXIAL VECTOR FORM FACTOR OF THE NUCLEON AND THE QUARK–PARTON MODEL. Kitani, K.; Tanabe, R.; Yoshii, H. (Tokyo Inst. of Tech.). Lett. Nuovo Cim.; 2: No. 15, 789-93(9 Oct 1971).

A relation between the threshold behavior of the deep inelastic electromagnetic structure function and the electromagnetic form factor of the nucleon was previously proposed by Bloom and Gilman Gilman. It is shown that under the Bloom–Gilman conjecture, the parton model gives the dipole form of the axial vector form factor $G_A(Q^2)$ and the mass relation $m_A \simeq \sqrt{2m_V}$. The behavior of the elastic electromagnetic form factor with Q^2 is also given. (L.B.S.)

Weak

Refer also to abstracts 59543 and 59544.

59392 (ORO-3992-69) LOWER BOUND ON λ_+ IN K_{l3} DECAY. Acharya, R. (Texas Univ., Austin. Center for Particle Theory). Aug 1971. 8p. (CPT-118). Dep. NTIS.

A lower bound on λ_+ is derived under the assumption that the chiral SU(2) × SU(2) breaking correction term to the soft-pion theorem in K_{l3} decay is positive. Earlier estimates of phenomenological parameters are adopted, and $\lambda_+ \gtrsim 0.05$ is obtained. (auth)

59393 SELECTION RULES IN THE WEAK INTERACTIONS AND THEIR RELATION TO HADRONIC MESONS. Kim, Bjong-Ro. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Progr. Theor. Phys. (Kyoto); 46: No. 1, 198-210(Jul 1971).

In the framework of a model of weak interactions developed previously, selection rules in weak interactions are considered. The isospin selection rules $|\Delta I| = 1$ and $|\Delta I| = \frac{1}{2}$ are consequences of the model. The hadronic vector and axialvector mesons are classified into first and second class mesons similar to S. Weinberg's classification of first and second class currents, thus giving physical meaning to notions of first and second class currents. Conclusions are reached on the existence of second class currents. The relation of the electromagnetic currents of the hadrons to the vector part of the neutral weak currents of the hadrons is discussed. These two currents are assumed to be the same and it is concluded from this that the possible existence of the isotensor electromagnetic currents is directly related to the possible existence of $|\Delta I| = 2$ weak processes or to the possible existence of mesons with isospin 2. This assumption leads to an "extended" C.V.C. in the sense that the isospin relation between the electromagnetic and weak currents is not limited to the isovector but extended to the isoscalar and isotensor. (auth)

59394 SEMI-LEPTONIC PROCESS. Ogawa, Shuzo (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 1, 343-5(Jul 1971).

The similarity between the hadron and the nucleus as composite systems is investigated by examining the semileptonic process of hadrons in comparison with nuclear β-decay. Selection rules are obtained for interactions of the type $\nu(\bar{\nu}) + N \rightarrow$ one meson + one baryon + $l(\bar{l})$. (L.B.S.)

59395 LEPTON–BARYON RESONANCES AND DUALITY IN WEAK PROCESSES. Nakawaki, Yuji (Osaka Univ.); Saito, Takesi; Sakai, Yosiki; Tanikawa, Yasutaka. Progr. Theor. Phys. (Kyoto); 46: No. 1, 346-8(Jul 1971).

The theory of duality was previously proposed and the process $\nu + n \rightarrow \mu^- + p$ was studied by using the Veneziano model, in which the $\mu^- p$ resonance (T boson) was considered to lie on a Regge trajectory $\alpha_T(s)$. The existence of a $\mu^+ n$ resonance (T′ boson), lying on a Regge trajectory $\alpha_{T'}(\mu)$, is assumed and is introduced into the pervious model. It is shown that the new model reduces the energy dependence of quantities corresponding to the vector and axial-vector form factors. (L.B.S.)

59396 NONLEPTONIC DECAYS OF THE NEUTRAL K MESONS AND THE LEE–SUGAWARA SUM RULE. Kohara, Yoji; Nishijima, Kazuhiko (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 1, 348-50(Jul 1971).

A simple set of selection rules for nonleptonic decays of the neutral K mesons is proposed, and it is shown that this new set of selection rules is equivalent to the Lee–Sugawara sum rule. (L.B.S.)

59397 APPLICATION OF ELEMENTARY PARTICLE TECHNIQUES TO PROBLEMS IN NUCLEAR WEAK INTERACTIONS. Frazier, John Melvin. Baltimore; Johns Hopkins Univ. (1971). 120p. University Microfilms Order No. 71-21,040.

Thesis.

The application of elementary particle techniques to strangeness conserving weak nuclear processes dates back to previous work. An extension of that work to several new problems is made. The field theoretical basis of the theory of weak processes is discussed, and the discussion is extended to strangeness-conserving weak nucleon processes; β-decay of the neutron, μ-capture in gaseous hydrogen, and γ-scattering off nucleons. Using the weak nucleon processes as a basis, quasielastic forward neutrino scattering off ^{27}Al and ^{56}Fe is investigated by means of the impulse approximation. Next the elementary particle treatment of three problems: μ-capture in ^{3}He, β-decay of R_2E, and radiative corrections to $O \rightarrow O$ β-transitions is carried out. (Diss. Abstr.)

59398 WEAK DECAYS OF THE Ω^- PARTICLE AND CURRENT ALGEBRA. Ram Mohan, Lakshminarayanapuram Ramdas. Lafayette, Ind.; Purdue Univ. (1971). 172p. University Microfilms Order No. 71-20,530.

Thesis.

The weak decays of the Ω^- particle are investigated in the framework of the current x current model of weak interactions, and the algebra of currents. Use is made of internal symmetries of elementary particles to generalize, and to extend, earlier calculations on hyperon decays to make predictions for the decays of the Ω^- particle. The weak currents and their form factors are determined by a combination of phenomenology and SU(6) symmetry applied in the static limit. This leads to predictions for the decay rates of the semileptonic decays of the Ω^- particle and reproduces the results obtained earlier. The nonleptonic decays are evaluated by using current algebra in the soft pion limit. The current algebra method reduces the problem to evaluating the matrix elements of the weak parity conserving current x current Hamiltonian between baryon states. The matrix element of the Hamiltonian between decuplet baryon states, the decuplet spurion, is evaluated by assuming that the matrix element is saturated by octet and decuplet single-particle intermediate states. With the simplest possible assumptions regarding the high energy behavior of the vector and axial-vector form factors of the baryons it is shown that the decuplet spurion exhibits octet dominance. Octet dominance arises due to a cancellation between the octet and the decuplet particle intermediate state contributions to the 27-plet part of the spurion. The p-wave decay amplitudes are obtained with baryon octet and decuplet spurion strengths as input. By assuming that the d-wave amplitudes for the decays $\Omega^- \rightarrow \Lambda K^-$, $\Xi\pi$ are given by the K*-pole model the predictions of the $\Delta T = \frac{1}{2}$ rule are obtained in the nonleptonic decays. The asymmetry parameter for $\Omega^- \rightarrow \Lambda K^-$ is predicted to be zero, and the $\Omega^- \rightarrow \Xi\pi$ decay modes are predicted to have a maximal ($\alpha \approx 1$) asymmetry parameter. It is pointed out that such a large asymmetry in the $\Xi\pi$ mode may allow a direct and unambiguous determination of the spin of the Ω^- particle from a measurement of the decay distributions by using the Lee and Yang inequalities in the averages of test functions over the decay distributions. The total decay rate for the nonleptonic decays agrees very well with experiment. The weak radiative decays $\Omega^- \rightarrow \Xi^-\gamma$ and $\Omega^- \rightarrow \Xi^{*-}\gamma$ were investigated in the pole approximation. Estimates for the decay rates and branching ratios to the corresponding pionic decay modes show that these radiative modes are the counterparts of the two-body weak radiative decays of the octet baryons. The predicted decay rates, however, are quite small and are comparable to the semileptonic decay rates. (Diss. Abstr.)

59399 LEPTONIC DECAYS OF MESONS. Silisteanu, Ion. Stud. Univ. Babes-Bolyai, Ser. Phys.; 16: No. 1, 15-19(1971).

New relations between transition amplitudes for leptonic decays of mesons and the mass of the soft-pion are obtained, which coincide with current-algebra and quark-model results of Iwasaki, Suzuki, and Sugawara. (L.B.S.)

59400 NUMERICAL SOLUTIONS OF THE KINETIC EQUATION FOR THE PASSAGE OF μ MESONS THROUGH MATTER. Kuz'mina, L. V. (Inst. of Applied Mathematics, Moscow). Chislennye Metody Mekh. Sploshnoi Sredy; 1: No. 1, 83-9(1970). (In Russian).

The energy losses at large, 10^5 to 10^8 MeV meson energies increase linearly with E. The kinetic equation with dimensionless depth and energy variables has been solved for the case, for which the μ meson flux had a clearly expressed gradual character. The problem was further examined under the boundary condition only a single meson with an energy of E_0 hits the layer. The solution was derived by approximation, using differential schemes; the results were compared with previous data. (TTT)

59401 TWO HIGH ENERGY PROCESSES INVOLVING DETECTED FINAL STATE PARTICLES. Landshoff, P. V.; Polkinghorne, J. C. (Cambridge Univ., Eng.). Nucl. Phys.; B33: No. 1, 221-38(1971).

Two processes are discussed: (a) semi-inclusive electroproduction experiments; (b) heavy-lepton pair production in hadronic collisions. The non-perturbative approach to the parton model is used to evaluate scaling properties and to consider extra contributions due to wee partons. These latter have not been previously discussed and are found to be important for process (b), but absent in process (a). Quantitative agreement is obtained for process (b), including an explanation of the observed shoulder in the differential cross section. (auth)

59402 PHOTON RADIATION DURING WEAK INTERACTION OF POLARIZED LEPTONS. Safronov, A. N. (Moscow State Univ.). Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 12: No. 2, 123-30(Mar-Apr 1971). (In Russian).

Within the framework of the theory of weak interactions, the properties of bremsstrahlung were investigated, along with neutrino annihilation of polarized leptons. This process forms photons which, in principle, may provide information concerning the vertex of the four-fermion interaction. Their angular and energy distribution, as well as the cross section behavior at large energies, depend strongly upon the polarization state of the initial particles. (tr-auth)

59403 NEW EXPERIMENTS IN NEUTRINO PHYSICS. Pontekorvo, B. Usp. Fiz. Nauk; 104: No. 1, 3-14(May 1971). (In Russian).

Certain questions drawn from present-day neutrino physics are explored. "Diagonal" and "non-diagonal" processes, stemming from the Hamiltonian, are of interest, but the nature of the former is still largely unknown. The possibility of neutrino sources other than pions and kaons is examined. Does the charge on a lepton persist, and is the mass of a neutrino really zero? As to the question "Is a neutrino–neutrino reaction possible?", it is concluded that such an interaction may occur in astrophysical, cosmic, and purely lepton processes. (30 references) (K.S.W.)

59404 NON-LOCAL EFFECTS IN THE DECAY OF POLARIZED MUONS. Pietschmann, H.; Stremnitzer, H. (Univ., Vienna). Nucl. Phys.; B22: No. 2, 493-6(1970).

The energy spectrum for electrons from the decay of polarized muons is calculated. V–A currents are assumed, but the interaction is not assumed to be local. The most general structure tensor is assumed to calculate the spectrum including terms up to the order $(m_e/m_\mu)^2$. (auth)

59405 VIOLATION OF THE $|\Delta I|$ absolute value = $\frac{1}{2}$ RULE IN NON-LEPTONIC DECAYS. Haan, Oswald; Stech, Berthold (Univ., Heidelberg). Nucl. Phys.; B22: No. 2, 448-60(1970).

Tree graph contributions to the non-leptonic decays are calculated. They give the correct order of magnitude for the $|\Delta I| = \frac{3}{2}$ amplitude; their contribution is, however, too large by roughly a factor 2. Since this result appears consistently in all accessible non-leptonic decays it is concluded that prominent parts of the non-leptonic amplitude as given by the tree-graph contributions are partially cancelled or suppressed by an unknown mechanism. (auth)

59406 COULOMB CORRECTIONS TO ADLER'S PCAC TEST IN NUCLEI. Nachtmann, O. (CERN, Geneva). Nucl. Phys.; B22: No. 2, 385-96(1970).

Coulomb corrections to the forward-inelastic neutrino cross section on nuclei are estimated, which, according to Adler's theorem, should be proportional to the pion cross section. An eikonal wave function is used for the muon in the final state. The pion is treated in a simple optical model also in the eikonal approximation. Corrections $\lessapprox 10\%$ are found for muon energy $E_2 \geq 1$ GeV and energy transfer $\nu \gtrapprox 0.5$ GeV in heavy nuclei. (auth)

59407 CERTAIN ASPECTS OF TWO-COMPONENT AND FOUR-COMPONENT THEORIES OF THE NEUTRINO FROM CONSIDERATION OF WEAK LEPTONIC AND SEMI-LEPTONIC PROCESSES. Kerimov, B. K.; Romanov, Yu. N. (Moscow

State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 2, 57-61 (1970). (In Russian).

The results of an application of two- and four-component neutrino theories to weak leptonic (muon decay) and semileptonic processes are compared. It is shown that the predictions of these two theories are evidently inequivalent in the V−A variant of the relation of electron and muon currents and also muon and baryon currents. According to the four-component theory in contrast to the two-component theory the V + A interaction of electron and muon currents is responsible for the muon decay. (tr-auth)

59408 SUM RULES FOR CP-NONCONSERVING BBπ AMPLITUDES IN GLASHOW'S MODEL. Ram Mohan, L. R. (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 4: No. 3, 825-30(1 Aug 1971).

Current algebra was used to derive sum rules for the CP-nonconserving $\Delta S = 1$ and $\Delta S = 0$ nonleptonic transitions $B \to B'\pi$ in Glashow's model. Within the saturation scheme of Chiu, Schechter, and Ueda for the matrix elements of the weak current × current Hamiltonian between single baryon states, it is shown that the CP-nonconserving amplitudes do have octet dominance. The one-pion exchange contribution to the weak P- and T-violating nucleon–nucleon potential was calculated by relating the weak NNπ vertex to hyperon decay amplitudes. (auth)

59409 ONCE-SUBTRACTED DISPERSION RELATIONS, CURRENT ALGEBRA, AND NONLEPTONIC WEAK DECAYS OF HYPERONS. Sebastian, K. J. (Lowell Technological Inst., Mass.). Phys. Rev., D; 4: No. 3, 771-84(1 Aug 1971).

Nonleptonic weak decays of hyperons and the $K_1 \to 2\pi$ decay are carefully analyzed using current algebra, partial conservation of axial-vector current, and once-subtracted dispersion relations, a method suggested by Okubo, Mathur, and Marshak. The dispersion integral is calculated by assuming it to be saturated by the low-mass intermediate states of the nucleon octet, of the $\frac{3}{2}^+$ decuplet of $\Delta(1236)$, and of the $\frac{1}{2}^-$ SU_3 singlet $Y_0^*(1405)$, in the case of hyperon decays, and by the intermediate states of vector mesons and a possible 0^+ scalar-meson nonet, in the case of $K_1 \to 2\pi$ decay. The matrix element of the parity-violating weak Hamiltonian density between two baryons (which is required to evaluate the hyperon decay amplitudes) is related to the $K_1 \to 2\pi$ decay amplitude by the K_1 tadpole mechanism. With pseudovector SU_3-symmetric coupling among the nucleon and pseudoscalar-meson octets, a good fitting of all the hyperon decay amplitudes is obtained in terms of four parameters. It is also found that the corrections to the soft-pion values are very important not only for P-wave hyperon decay amplitudes, but also for S-wave amplitudes. They are also extremely important for $K_1 \to 2\pi$ decays. Furthermore, it is found that, contrary to the findings of Hara and Nambu, there is no evidence for the concept of a "universal parity-conserving spurion" in hyperon and $K_1 \to 2\pi$ weak decays. (auth)

59410 INTERMEDIATE BOSON. II. THEORETICAL MUON SPECTRA IN HIGH-ENERGY NEUTRINO EXPERIMENTS. Brown, R. W. (Brookhaven National Lab., Upton, N. Y. Case Western Reserve Univ., Cleveland); Hobbs, R. H.; Smith, J. Phys. Rev., D; 4: No. 3, 794-813(1 Aug 1971).

The theoretical angular and energy distributions are presented for the W boson, the "prompt" muon, and the decay muon in the reaction $\nu + Z \to Z + W + \mu$ with the subsequent fast decay $W \to \mu + \nu$. A discussion of the W's polarization is included. In particular, the deep-inelastic contributions to the incoherent production mode and the effect of the W's anomalous magnetic moment are considered. Emphasis is on the energies available at the National Accelerator Laboratory and corresponding attainable W-boson masses. (auth)

59411 NEW IMPROVED BOUNDS FOR K_{l3} PARAMETERS. Okubo, Susumu (Univ. of Rochester, N. Y.). Phys. Rev. D; 4: No. 3, 725-33(1 Aug 1971).

New exact bounds for derivatives of K_{l3} decay form factors $f_\pm(t)$ are obtained, provided that $\Delta(0)$, the propagator of the divergence of the strangeness-changing current at zero momentum, is known. Several estimates of $\Delta(0)$ are discussed, along with their experimental implications. (auth)

59412 $\pi^+ \to e^+(\mu^+)\nu e^+e^-$ DECAYS. Bardin, D. Yu.; Bilen'kii, S. M.; Mitsel'makher, G. V.; Shumeiko, N. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 14: No. 2, 427-36(Aug 1971). (In Russian).

The integral probability of the process $\pi^+ \to l^+\nu_l e^+e^-$ is calculated. It is shown that the investigation of the $\pi^+ \to e^+\nu_e e^+e^-$ decay at various detection thresholds of final charged particles allows one to get information on the γ parameter (the ratio of the axial form factor for the vector one in the $\pi^+ \to e^+\nu_e\gamma$ decay) on the π-meson electromagnetic radius and on the sign of the $\pi^0 \to \gamma\gamma$ amplitude. (auth)

59413 ANGULAR AND MOMENTUM DISTRIBUTIONS OF μ^+ MESONS FROM W^+-BOSON DECAY IN REACTION $\nu_\mu + Z \to \mu^- + Z + W^+$. Berkov, A. V.; Zhizhin, E. D.; Nikitin, Yu. P.; Shabalin, E. P. (Moscow Engineering-Physics Inst. Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 2, 422-6(Aug 1971). (In Russian).

The calculations are presented of the double differential spectra of μ^+ mesons (or positrons) from the decay of the W^+-boson produced in reaction $\nu_\mu + Z \to \mu^- + W^+ + Z$. (auth)

59414 ANGULAR AND MOMENTUM DISTRIBUTIONS OF μ^- MESONS IN REACTION $\nu + Z \to \mu^- + W^+ + Z$. Zhizhin, E. D.; Nikitin, Yu. P.; Rozhnov, G. V.; Shabalin, E. P. (Moscow Engineering-Physics Inst. Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 14: No. 2, 420-1(Aug 1971). (In Russian).

The μ^--meson angular spectra, and double differential angular and momentum spectra are presented for the reaction $\nu_\mu + Z \to \mu^- + W^+ + Z$. The calculations are carried out in the mass interval $3 \leq m_W \leq 7$ GeV for the W-bosons produced on nucleons and Fe nuclei. (auth)

59415 ANGULAR AND MOMENTUM DISTRIBUTIONS OF μ^+ MESONS (OR POSITRONS) IN REACTIONS OF DIRECT PRODUCTION OF LEPTONIC PAIRS BY NEUTRINO BEAM IN ELECTROMAGNETIC FIELD OF NUCLEI AND NUCLEONS. Berkov, A. V.; Voronina, L. M.; Shabalin, E. P. Yadern. Fiz.; 14: No. 2, 416-19(Aug 1971). (In Russian).

The calculations are presented of the double differential spectra of $\mu^+(e^+)$ in reactions $\nu_\mu + Z \to \mu^+ + \mu^- + \nu_\mu + Z$ and $\nu_\mu + Z \to \mu^- + e^+ + \nu_e + Z$ in the electromagnetic field of nucleons and the Fe nucleus. (auth)

59416 INVESTIGATION OF THE TOTAL RADIATIVE CORRECTIONS TO THE RATIO G_β^V/G_μ IN THE MODEL WITH INTERMEDIATE VECTOR MESON. Manida, S. N. (Leningrad State Univ.). Yadern. Fiz.; 14: No. 2, 408-15(Aug 1971). (In Russian).

Radiative corrections to the β and μ decays are considered. In each order for the fine-structure constant α the diagrams are revealed giving the most nonuniversal contribution. The selected diagrams are summarized into the diagrams of the first order in the constant α with the total Green functions of the meson and photon and with the total vertex parts. (auth)

59417 ANALYSIS OF NEUTRINO EXPERIMENTS IN COSMIC RAYS. Volkova, L. V.; Zatsepin, G. T. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 14: No. 1, 211-20(Jul 1971). (In Russian).

The spectra of muons emerging from the cosmic ray neutrinos are calculated under different assumptions on the behavior of the total cross section of neutrino–nucleon interaction. The results of the neutrino experiments in cosmic rays do not contradict the assumption of an unlimited rise of the neutrino–nucleon interaction total cross section with the neutrino energy. However, due to large uncertainties in the experimental and calculated muon fluxes the results of the experiments can also agree with the assumption on the cut off of the linear increase of the cross section at the neutrino energy of some dozens or hundreds GeV. (auth)

59418 EFFECTIVE LAGRANGIAN OF NONLEPTONIC WEAK INTERACTIONS AND PARITY-NONCONSERVING NUCLEAR FORCES. Kapustnikov, A. A. (Dnepropetrovsk State Univ., USSR). Yadern. Fiz.; 14: No. 1, 221-5(Jul 1971). (In Russian).

Using the hypothesis on the right SU(3) invariance, the effective Lagrangian for nonleptonic weak interactions containing the $\Delta S = 0$ and $\Delta S = 1$ parts is constructed. According to the assumption, the parity conserving part is related to the strong interaction Lagrangian by the unitary transformation. The kind of the transformation operator is determined from relation to the Cabibbo theory. The application of this Lagrangian to the process $n + p \to d + \gamma$ is considered. (auth)

59419 SUGGESTION CONCERNING THE PRESENT ANOMALY IN RATE $(K_L \to \mu^+\mu^-)$ RATE $(K_L \to 2\gamma)$. Barshay, S. (Univ. of Copenhagen). Phys. Lett.; 36B: No. 6, 571-2(18 Oct 1971).

Christ and Lee have emphasized that if the recently reported preliminary measurement of the rate for $K_L \to \mu^+\mu^-$ indeed falls below a unitarity lower bound of 1.1×10^{-1} sec^{-1}, then the possible influence of CP noninvariance must be examined. Using a published specific model in which the CP-violating parameter ϵ was calculated, CP-violating rates were calculated for $K_L \to 2\gamma$ and $K_L \to \pi^+\pi^-\gamma$ to be about 2.6×10^4 sec^{-1} and 0.2×10^3 sec^{-1} respectively.

XUM

The implications for the rates for $K_L \rightarrow \mu^+\mu^-$ and $K_S \rightarrow \mu^+\mu^-$ are discussed. (auth)

59420 EXPLANATION FOR NONLEPTONIC DECAYS OF HYPERONS. Nagai, Y. E. (Michigan State Univ., East Lansing). Phys. Lett.; 36B: No. 6, 568-70(18 Oct 1971).

On the basis of Okubo's dispersion approach, the resonance contribution to the current algebra result for nonleptonic decays of hyperons is calculated via Regge theory. A four parameter best-fit solution to both s and p-wave amplitudes is found to be in very good agreement with experiment. The result provides a uniform explanation of puzzling features of previous work. (auth)

Strong (General)

Refer also to abstract 58432.

59421 (COO–2009-30) EQUIVALENCE OF REGGE AND OPTICAL MODELS. Hendry, Archibald W. (Indiana Univ., Bloomington. Dept. of Physics). [nd]. Contract AT(11-1)-2009. 25p. (CONF-710627-1). Dep. NTIS.

From Two body scattering at high energy conference; Argonne, Ill. (21 Jun 1971).

The equivalence of the Regge and optical models is discussed for scattering at intermediate energies. Surface scattering is also considered. (J.F.P.)

59422 (JINR–E2-6046) QUASIPOTENTIAL FORMALISM FOR THE TWO-PARTICLE SYSTEM WITH SPINS 0 AND ½. Garsevanishvili, V. R.; Goloskokov, S. V.; Matveev, V. A.; Slepchenko, L. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 13p. Dep. NTIS (U. S. Sales Only).

The quasipotential formalism for the particles with spins 0 and ½ was developed. The quasipotential equations for the scattering amplitude and the wave function were derived. (auth)

59423 CORRESPONDNCE BETWEEN THE THREE-TRIPLET MODEL AND THE QUARTET MODEL IN NONLEPTONIC HYPERON DECAYS. Murayama, Akihiro (Shizuoka Univ., Japan). Progr. Theor. Phys. (Kyoto); 46: No. 1, 338-40(Jul 1971).

It has been pointed out that in the quartet model, under the assumptions of the weak two-body interaction and additivity, the main properties of P-wave nonleptonic decays of hyperons are explained well by the two urbaryon transitions. It is shown that in the three-triplet model there exists a transition corresponding to the two-urbaryon transition in the quartet model, if baryons and mesons are mixed states of $SU(3)' \times SU(3)''$ and if the decay is caused by the (S or V) – (T or A) type weak potential between two urbaryons. (L.B.S.)

59424 EXPERIMENTAL VERIFICATION OF DISPERSION THEORY AND HIGH ENERGY SCATTERING. Lindenbaum, S. J. (Brookhaven National Lab., Upton, N. Y.). Fields Quanta; 1: No. 4, 255-93(Jul 1971).

A review is presented of the status of experiments to test forward dispersion relations. After discussing the relevance of these measurements, the apparatus is briefly described. This is followed by a description of exactly how the theory is tested. The second portion is devoted to the subject of the Pomeranchuk theorem and the recent total cross section data from Serpukhov. These results are compared with the extrapolations of experimental data. (auth)

59425 DISPERSION THEORY AND THE COMPLEX J-PLANE. Mandelstam, Stanley (Univ. of California, Berkeley). Fields Quanta; 1: No. 4, 295-343(Jul 1971).

Some of the basic ideas of dispersion theory are reviewed and examples of the successful applications of the theory in understanding elementary particle reactions are presented. The principles of Regge theory including phenomenological applications and the composite nature of Regge recurrences are discussed. Finally, the prospects for dynamical calculations based on dispersion relations and Regge theory are discussed. (auth)

59426 BOUND STATES AND MASS SPECTRA OF HADRONS IN THE QUARK MODEL. Animalu, A. O. E. (Drexel Univ., Philadelphia). Lett. Nuovo Cim.; 2: No. 14, 677-80(2 Oct 1971).

It is shown that under the supposition that quarks in hadrons are bound by pair excitations (gluons) of the type $P\bar{P}$, $N\bar{N}$, $\lambda\bar{\lambda}$ or integral multiples thereof, which make no contributions to the internal quantum numbers, but contribute integral multiples of $2m_P$, $2m_N$, $2m_\lambda$ respectively to the hadron mass (m_h), the mass spectra of all known hadrons can be explained by the principle of unitary isotopes. (L.B.S.)

59427 TRANSVERSE-MOMENTUM DISTRIBUTION OF PRODUCED SECONDARIES FROM STATISTICAL THERMODYNAMIC MODELS OF STRONG INTERACTIONS AT HIGH ENERGIES. Wayland, J. R. (Texas A and M Univ., College Station). Nuovo Cim.; 5A: No. 2, 273-4(21 Sep 1971).

The asymptotic form for the transverse-momentum (P_t) distribution of secondary particles determined by statistical thermodynamic models of high-energy interactions is limited to certain values of P_t. The complete form and its relation to the asymptotic relation are considered. (auth)

59428 SCALING LAW FOR DEEP-INELASTIC HADRONIC SCATTERING. Huang, Kerson; Segre, Gino (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev. Lett.; 27: No. 16, 1095-8(18 Oct 1971).

The dual-resonance model suggests a new scaling law for the inclusive reaction $A + B \rightarrow X +$ anything at fixed production angle in the cm frame at high energies. The prediction is that $s^{-1} \ln (d^2\sigma/dqd\Omega)_{cm}$ approaches, up to a multiplicative constant, a universal function independent of s. The form of the function is simple and explicitly given. In the quasi-elastic limit this function approaches that predicted for wide-angle elastic scattering by the Veneziano model. Agreement with experiments is good. (auth)

59429 PHENOMENOLOGICAL ANALYSIS OF PION CONSPIRACY MODELS. Brown, Nicholas Everett. San Diego, Calif.; Univ. of California (1971). 75p. University Microfilms Order No. 71-21,685.

Thesis.

For several years the suggestion of a conspiring pion has been used by various phenomenologists to explain the forward differential cross sections of charged pion photoproduction and nucleon-nucleon charge exchange scattering. However, the "classical" conspiracy model has encountered various experimental and theoretical difficulties. Two conspiracy models are exhibited which avoid these difficulties and are compared with other work in the field of Regge pole and cut phenomenology. Insofar as there are no generally accepted criteria by which the best of these many models can be determined, only relative conclusions can be drawn. (Diss. Abstr.)

59430 BREAKING OF SCALE INVARIANCE: REGGE TRAJECTORIES, AND DYONS. Bakesigaki, A.; Inomata, A. (State Univ. of New York, Albany). Lett. Nuovo Cim.; 2: No. 14, 697-700(2 Oct 1971).

A scheme for breaking of scale invariance that results in SO(4,1) is applied to the hadron viewed as a composite of dyons. On the basis of the resulting symmetry, without specifying the internal structure of the composite, a mass formula corresponding to Regge trajectories is derived, and a simple model for Salam's strong gravity is presented. An order-of-magnitude estimate is made of the dyon mass in a dyonium. (L.B.S.)

59431 GALILEAN INVARIANCE IN THE INFINITE MOMENTUM FRAME AND THE PARTON MODEL. Bouchiat, Cl.; Fayet, P.; Meyer, Ph. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B34: No. 1, 157-76(1971).

Field theory in the infinite momentum frame variables is used to derive the parton model, and to stress the implications of transverse Galilean and longitudinal Lorentz boost invariances. The elastic nucleon electromagnetic form factor and inelastic structure functions are expressed as density and correlation functions for partons in the transverse plane, in direct analogy with expressions of non-relativistic atomic physics. A connection is established between the transverse momentum cut-off and the q^2 dependence of the electromagnetic elastic form factor. The scaling law for the parton model is derived under conditions which appear in a rather transparent way. The corresponding sum rules are studied. A generalization of the Bjorken-Feynman scaling is obtained in the nonforward Compton scattering amplitude relevant to the two-photon correction in very high-energy electron-nucleon elastic scattering. (auth)

59432 LORENTZ-INVARIANT AND NON-INVARIANT MOMENTUM SPACE AND THERMODYNAMICS. Jabs, Arthur (Univ., Kiel). Nucl. Phys.; B34: No. 1, 177-88(1971).

It is demonstrated that the relations of thermodynamics can be obtained from the ordinary non-invariant but not from Srivastava's and Sudarshan's Lorentz-invariant momentum space. The relations refer to the extreme relativistic case where the thermodynamic Planck distribution is known to be correct. Therefore only the non-invariant momentum space is the legitimate representative of the statistical hypothesis, and the question of taking Lorentz-invariant or non-invariant momentum space in the statistical

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model of high-energy interactions is to be reinterpreted as a statement about the transition-matrix element. (auth)

59433 ONE-LOOP AMPLITUDES IN THE MODEL OF NEVEU AND SCHWARZ. Goddard, P.; Waltz, R. E. (CERN, Geneva). Nucl. Phys.; B34: No. 1, 99-108(1971).

Dual one-loop amplitudes for external pions are constructed from the Born term of Neveu and Schwarz. Non-orientable diagrams are needed, although the model has SU(2) symmetry. The Pomeranchukon-like singularity now has intercept greater than one and there is also a negative G-parity isoscalar singularity with zero intercept generated by the same mechanism. The divergences can be removed by an extension of previous procedures. (auth)

59434 COMPLEX REGGE POLES. Barger, V. (Univ. of Wisconsin, Madison); Phillips, R. J. N. Contract AT(11-1)-881. Nucl. Phys.; B33: No. 1, 200-13(1971).

The practical consequences of introducing conjugate complex pairs of Regge poles, in place of the usual real boson Regge poles, are considered. A range of properties is discussed systematically. (auth)

59435 FUNCTIONAL APPROACH TO DUAL QUARK MODELS. Kaku, M.; Virasoro, M. A.; Yoshimura, M. (Univ. of California, Berkeley). Nucl. Phys.; B33: No. 1, 109-34(1971).

The usual N-point Veneziano amplitude can be obtained by summing over a large class of fishnet diagrams if one assumes a φ^4 interaction and suitable approximations. By adding fermion (quark) propagators along the edges of these fishnet diagrams, a natural generalization of this functional approach to include mesons and baryons without exotics is obtained, which smoothly extrapolates to the multiplicative model. By functionally integrating over a two-dimensional strip, creation and annihilation operators are introduced and solved for the generators of the conformal group. The mechanism to kill spin ghosts was not found. And because all functional integrations are difficult to perform, the amplitude is obtained by a perturbation series. Because the series in this approximation diverges, the renormalization scheme is also discussed. SU(3) breaking can be introduced in a natural way. (auth)

59436 TWO-PARTICLE CORRELATIONS IN HIGH ENERGY PRODUCTION EXPERIMENTS. Bassetto, A. (CERN, Geneva); Toller, M.; Sertorio, L. Nucl. Phys.; B34: No. 1, 1-40(1971).

One-particle and two-particle inclusive distributions are considered in the light of future production experiments at CERN Intersecting Storage Rings machine. The general properties of those models are discussed, which are based on factorized approximations to the production amplitudes and are in agreement with some general hypotheses like the Feynman scaling law. First the role of phase space arguments is clarified and the importance of detecting correlations in high energy production experiments as a hint for understanding the underlying dynamics is emphasized. Then two peculiar (and, in a sense, complementary) kinds of correlation in two-particle inclusive distributions are examined: the one coming from multiperipheral dynamics with Lorentz pole exchanges, the other due to "direct channel" resonances. Some general properties of inclusive distributions are expressed in terms of quantities which are suitable for direct measurement. (auth)

59437 SOME PROBLEMS WITH THE QUARK MODEL FOR ELEMENTARY PARTICLES. Dalitz, R. H. (Oxford Univ.). pp 343-80 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

59438 NON-EXPONENTIAL DECAYS IN A LEE MODEL WITH SEVERAL UNSTABLE V-PARTICLES. Ruuskanen, P. V. (Univ. of Helsinki). Nucl. Phys.; B22: No. 1, 253-68(1970).

The time dependence of several closely located interfering unstable states using an extended Lee model and give a unified treatment of different decay laws which can arise depending on the parameters of the system. (auth)

59439 UNSTABLE PARTICLE AND A DUAL-CUT MODEL. Yang, Ying-chuan (National Tsing Hua Univ., Hsinchu, Taiwan). Nuovo Cim.; 5A: No. 3, 407-12(1 Oct 1971).

The unstable-particle solution was obtained from the Bethe–Salpeter equation. The solution is connected with a timelike potential, and is due to a continuous cut contribution. A dual-cut model is introduced, and the scattering amplitude is obtained by adding a series of dual-cut amplitudes to the dual-resonance amplitude. (auth)

59440 SELECTION RULES FOR REGGE CUTS. Finkelstein, J. (CERN, Geneva). Nuovo Cim.; 5A: No. 3, 413-20(1 Oct 1971).

The expectation that diagrams which generate Regge cuts must contain third double-spectral functions is combined with the requirements of exchange degeneracy to arrive at a selection rule for Regge cuts. This rule prohibits Regge–Regge cuts from contributing to KN scattering, and it is speculated that this prohibition might explain the observation that the K^+p total cross section is such a remarkably constant function of energy, and that the cross sections for KN and $\bar{K}N$ charge-exchange scattering rapidly become equal as the energy increases. (auth)

59441 DUAL-RESONANCE MODEL WITH UNEQUAL INTERCEPTS. Gordon, E. M.; Lam, C. S. (McGill Univ., Montreal). Nuovo Cim.; 5A: No. 3, 495-510(1 Oct 1971).

The dual-resonance operator formalism is extended to the case of unequal intercepts in all channels. By imposing factorization a parametrization of the Regge trajectories is obtained and a quark picture of the dual model is considered. Whereas some of the operators of the theory remain unchanged in the unequal-intercept case, others such as the gauge operator are modified. These modifications have effects that reinforce the quark interpretation of the dual-resonance amplitude. Ghost compensation on the first daughter trajectory is still valid providing certain conditions on the quark "masses" are satisfied. Finally, an $SU_{1,1}$ analysis of the N-point amplitude is displayed by coupling N "vertex fields", each with different $SU_{1,1}$ spin, to an $SU_{1,1}$ scalar. (auth)

59442 QUASIPOTENTIAL THEORY OF HIGH-ENERGY HADRON SCATTERING. Garsevanishvili, V. R.; Matveev, V. A.; Slepchenko, L. A.; Tavkhelidze, A. N. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 4: No. 3, 849-61(1 Aug 1971).

A quasipotential approach to the high-energy scattering of hadrons is developed. The consideration is based on the quasipotential equation for the scattering amplitude in quantum field theory, and on the physical assumption of the nonsingular character of hadron interactions at high energies. The results of the theoretical calculation are compared with experimental data on elastic nucleon–nucleon and isobar production processes. (auth)

59443 HARD-MESON CURRENT ALGEBRA AND THE BREAKDOWN OF PARTIAL CONSERVATION OF AXIAL-VECTOR CURRENT. Miller, M. G. (Northeastern Univ., Boston). Phys. Rev., D; 4: No. 3, 757-69(1 Aug 1971).

The Arnowitt–Friedman–Nath model of PCAC (partially conserved axial-vector current) breakdown which permits the two-body photon decays of π^0, η, and vector mesons is extended to the η' meson and to higher order. The model is required to satisfy a set of conditions, the most important of which is that it be consistent with SU(3) × SU(3) hard-meson current algebra. It is shown that if PCAC is no longer pole-dominated, then the general σ commutator, $[A_a^0, \partial_\mu A_b^\mu]$, cannot be pole-dominated either. In addition, the variation of the Lagrangian under chiral transformations will no longer be proportional to the divergence of the current. The model is used to calculate decay widths for the processes $\eta' \to \rho^0 + \gamma$, $\eta' \to 2\gamma$, $\omega \to 3\pi$, $\varphi \to 3\pi$, and $\eta \to 2\pi + \gamma$ with good success. (auth)

59444 INCLUSIVE PROCESSES AT LARGE TRANSFERRED MOMENTA. Abramovskii, V. A.; Kancheli, O. V.; Matinyan, S. G. (Inst. of Physics, Tbilissi, USSR). Phys. Lett.; 36B: No. 6, 565-7(18 Oct 1971).

A hadron inclusive process is considered in the case that the observed particle has a large transverse momentum $Q_\perp$. The "three particle optical-like theorem" is used. The process is determined by Regge cuts. The cross sections are shown to be of Orear type; the multiplicity of secondary particles $\sim Q_\perp$. (auth)

59445 RELATIVE IMPORTANCE OF DUAL LOOPS. Frampton, P. H. (CERN, Geneva). Phys. Lett.; 36B: No. 6, 591-2 (18 Oct 1971).

It is suggested that the size of a dual loop term is determined by the number of quark lines, rather than the power of g. This could explain the smallness of the triple-Pomeron vertex. (auth)

59446 PLANAR DUALITY CONSTRAINTS ON THE MULTIBODY MODEL. Boguta, J. (Univ., Bonn). Lett. Nuovo Cim.; 2: No. 15, 743-8(9 Oct 1971).

It is shown that general conditions can be formulated for the N-point function from which the N-point function and, by factorization, the four-point function with its desired zeros can be constructed.

From these conditions an isobaric model for the five-point function is constructed. (L.B.S.)

59447 ATOMS WITH MAGNETIC CHARGES AS MODELS OF HADRONS. Barut, A. O. (Univ. of Colorado, Boulder). pp 15-45 of Topics in Modern Physics. /Brittin, Wesley E. (ed.). Boulder, Colo.; Colorado Associated Univ. Press (1971).

The author presents evidence available so far concerning the assertion that the Kepler problem is once again the dynamical basis of the structure of matter, this time at the level of hadrons. Maybe nature repeats itself: from the weak classical gravitational potential energy $U_G = -(GMm/r)$, to the quantum mechanical electrostatic potential energy $U_e = -(1/4\pi\epsilon_0) \times (e^2/r)$, to the potential energy between two particles having both electric and magnetic charges (e and g) $U_g = -(e^2 + g^2)/(4\pi\epsilon_0 r)$, which is now a strong long-range Coulomb force. In each level a new feature manifests itself: quantum effects in the case of the H atom and magnetic charges in the case of very strong long-range force which may require new ways of handling the resultant quantum electrodynamics. Some answers are offered to the following two questions: (1) How does the new atomic physics look? (2) Can we reduce the nuclear forces, the problem of the constitution of nucleons and hadrons, and nuclei back to the symmetric electromagnetic origin? (auth)

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Refer also to abstracts 59296, 59550–59552, 59555, 59573, and 59618.

59448 (JINR–E2-6025) COHERENT STATE METHOD AND THE QUARK MODEL. Bogolyubov, P. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 16p. Dep. NTIS (U. S. Sales Only).

The connection of the coherent state method for the high-energy hadron scattering with the quark models is shown. (auth)

59449 CHIRAL INVARIANT LAGRANGIAN WITH MASSIVE GAUGE FIELDS: DECAYS OF SCALAR MESONS AND $\pi\pi$ SCATTERING. Suzuki, Tsuneo (Nagoya Univ., Japan); Uchida, Tomiyoshi; Hattori, Chuichiro. Progr. Theor. Phys. (Kyoto); 46: No. 1, 220-34(Jul 1971).

On the basis of a linear realization of chiral SW(2) symmetry, decay processes such as $\delta(966) \to \eta\pi$, $\sigma(730) \to 2\pi$, $\eta_V(1060) \to 2\pi$ and $K_V(1160) \to K\pi$ are discussed. It is shown that unless any derivative couplings are introduced, the generalized σ-model gives unacceptably large values for the decay widths. A model which incorporates massive chiral gauge fields, on the other hand, leads us to reasonable values. The latter model is found to yield Weinberg's results on π-π scattering lengths in the first order approximation. Corrections to his results are also given. (auth)

59450 FINITE ENERGY SUM RULES WITH $\pi\pi$ VENEZIANO AMPLITUDES. Selva, A. Della (Univ., Naples); Masperi, L. Progr. Theor. Phys. (Kyoto); 46: No. 1, 190-7(Jul 1971).

Veneziano amplitudes for $\pi\pi$ scattering are analyzed with regards to finite energy sum rules. It is shown that significant discrepancies may appear in the evaluation of FESR for real parts of non-forward scattering amplitudes. On the contrary, failure of FESR for the imaginary part of the amplitude only appears when the second daughter Regge pole is included. Possible phenomenological implications are discussed. (auth)

59451 PHYSICS OF A REGGE TRAJECTORY WITH A FINITE ASYMPTOTIC PHASE. Sivers, Dennis Wayne. Berkeley, Calif.; Univ. of California (1970). 37p. University Microfilms Order No. 71-20,910.
Thesis.

The hypothesis that the width of a resonance on a leading Regge trajectory is proportional to its mass is compared to the alternative that high-spin resonances become very stable. When the width grows with the mass, it is observed that the kinematics allow decay channels to have low orbital angular momentum. The dynamical implications of this observation are discussed. (Diss. Abstr.)

59452 SOME EXACT INEQUALITIES INVOLVING S AND P WAVES AND THEIR DERIVATIVES FOR πK SCATTERING. Ader, J. P.; Villani, A.; Zimerman, A. H. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Nuovo Cim.; 5A: No. 2, 258-72 (21 Sep 1971).

Inequalities involving the S and P πK partial-wave amplitudes and their derivatives are obtained via the methods used in recent works on pion-pion scattering. (auth)

59453 RELATIVISTIC EIKONAL AMPLITUDE AND RADIATIVE CORRECTIONS. Islam, M. M. (Univ. of Connecticut, Storrs). Nuovo Cim.; 5A: No. 2, 315-44(21 Sep 1971).

A relativistic eikonal amplitude for the generalized ladder diagrams with radiative corrections to all orders is derived. The connection between this approach and the graphical analysis of infra-red divergence in quantum electrodynamics is explicitly exhibited. The discrepancy between the Lévy-Sucher formula and that of Schiff is resolved. Inclusion of radiative corrections due to nonsoft mesons at the vertices of a hard interaction is investigated, and the difference with results obtained previously is noted. (auth)

59454 LOCALISABILITY AND SINGLE-PARTICLE EXCHANGE AMPLITUDES. Rivers, R. J. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B34: No. 1, 92-8 (1971).

It is shown that if zero-width mesons on a single linear trajectory interact with scalar mesons via a strictly-localisable Hamiltonian, the single-particle exchange amplitude does not have Regge pole behavior. (auth)

59455 SOFT PION–PION SCATTERING TO FOURTH ORDER IN MOMENTA AND EFFECTIVE CHIRAL LAGRANGIANS. Cornwell, D. T.; Taylor, J. C. (Oxford Univ.). Nucl. Phys.; B34: No. 1, 117-24(1971).

The maximum amount of information is extracted from current algebra and PCAC about the off-shell $\pi\pi$ scattering amplitude. To fourth order in the momenta and the pion mass, the amplitude is determined up to four unknown coefficients (a general amplitude would contain nine). An effective, linear σ-model Lagrangian which reproduces these four parameters is described. The non-linear σ-model is able to reproduce only three of them, unless the constraint equation is generalized to include derivatives. (auth)

59456 SIX PION AMPLITUDE TO FOURTH ORDER IN MOMENTA. Cornwell, D. T. (Oxford Univ.). Nucl. Phys.; B34: No. 1, 125-35(1971).

The six pion function is determined to fourth order in momenta and the pion mass using a generalized non-linear sigma model. All arbitrariness in the amplitude is shown to come from the four pion vertex, namely four parameters (or only one if we wish for an algebraically dual form). (auth)

59457 REMOVAL OF THE DEGENERACY IN THE DUAL RESONANCE MODEL. Eguchi, Tohru (Tokyo Univ.). Nucl. Phys.; B34: No. 1, 237-52(1971).

A general formula is given which enables the trajectory shift of any of the non-spurious resonances states caused by one loop perturbation to be calculated. As immediate applications, the shift of the parent trajectory and the removal of two-fold degeneracy of the first daughter trajectory are explicitly shown. Further, a suggestion is given that the one loop perturbation would completely remove the degeneracies of daughter trajectories and the residual degeneracies would be only accidental, even though the degree of degeneracy increases exponentially with mass. (auth)

59458 CONSTRAINTS IMPOSED ON $\pi^0\pi^0$ S- AND D-WAVES BY ANALYTICITY, CROSSING, AND POSITIVITY. Common, A. K. (Univ. of Kent, Canterbury, Eng.); Pennington, M. R. Nucl. Phys.; B34: No. 1, 253-68(1971).

The consequences of combining the Balachandran–Nuyts crossing conditions with the moment representation for $\pi^0\pi^0 \to \pi^0\pi^0$ partial waves are investigated. It is found that the constraints obtained previously from just the positivity of these waves are made much tighter. (auth)

59459 LOWER BOUND ON AMPLITUDES BELOW THRESHOLD FOR $\pi^0\pi^0$ SCATTERING. Arai, Masahiko (Tokyo Univ.). Nucl. Phys.; B34: No. 1, 71-6(1971).

A formula which expresses a lower bound on the amplitude F(s,0,4-s) for $\pi^0\pi^0$ scattering below threshold is given by the use of unitarity, analyticity and crossing symmetry. For $4 \geq s \geq 3.82$, this formula gives $F(s,0,4-s) > -32$. (auth)

59460 PION REGGE TRAJECTORY. Capella, A. (Faculte des Sciences, Orsay, France). Nucl. Phys.; B22: No. 1, 225-34(1970).

It is assumed that the pion belongs to a M = 0 (non-conspiring) parent Regge trajectory and deduce the minimal t = 0 behavior of its Regge residues and the residues of its various daughters using only analyticity and factorization. It turns out that the pion trajectory decouples from any pair of identical particles at t = 0. It is shown that, if according to the usual soft pion philosophy, one can put $\alpha_\pi = 0$ at t = 0, the same t = 0 behavior is arrived at starting from simple physical considerations based on an analogy with an elementary pion exchange. This is in favor of the assumption above on the classification of the pion. (auth)

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59461 DECAYS OF INTERFERING RESONANCES AND STATISTICAL TENSORS. Kotanski, A. (Jagellonian Univ., Krakow); Zalewski, K. Nucl. Phys.; B22: No. 1, 317-26(1970).

Statistical tensors are used to describe the angular decay distributions of interfering resonances both in single and double resonance production. The rules are given which enable one to find the relative parity of the interfering objects. The following examples are discussed in detail: the $\rho^0-\epsilon$ interference, the interference of the A_2 meson with a 2^- or 1^+ background, and the interference of the f^0 meson with a 0^+ background. (auth)

59462 VENEZIANO MODEL AND UNITARITY SUM RULES. Igi, K. (Tokyo Univ.); Storrow, J. K. Nucl. Phys.; B22: No. 2, 594-604(1970).

An attempt is made to place an additional constraint on the Veneziano-type model for $\pi\pi$ scattering by using a non-linear sum rule which incorporates unitarity. This sum rule, which was first derived by Arbad and Slansky, is called a unitarity sum rule (USR). Various uses of USRs are discussed, using the Veneziano model as an illustration. (auth)

59463 INFORMATION ON LOW-ENERGY $\pi\pi$ INTERACTION FROM ELASTIC PION–NUCLEON PHASE SHIFTS. Nielsen, H.; Petersen, J. Lyng; Pietarinen, E. (NORDITA, Copenhagen). Nucl. Phys.; B22: No. 2, 525-66(1970).

The well-known methods of partial-wave dispersion relations and backward amplitude dispersion relations for analyzing πN phase shifts with a view to obtain the low-energy $\pi\pi$ interaction have been modified by means of recent theories for performing analytic continuation of experimental data in order to obtain a unified model independent treatment. Good agreement between the two methods can be obtained only after a most important correction term has been taken into account, a fact which was overlooked in all previous applications of backward dispersion relations. First results of application of the FESR method for calculating a partial-wave amplitude in an extended region on the left-hand cut are presented. Results for the T = J = 1 $\pi\pi \rightarrow N\bar{N}$ interaction are in accordance with results of Höhler et al. Results for the T = J = 0 case are against a phase shift that resonates clearly below 900 MeV and in favor of the up-down or down-down solution. Some information on $\pi\pi$ d-waves is given. (auth)

59464 VENEZIANO MODEL FOR THE PROCESS $A_\mu\pi \rightarrow A_\mu\pi$. Csikor, F. (Eoetvoe Lorand Univ., Budapest). Yadern. Fiz.; 14: No. 1, 232-9(Jul 1971). (In Russian).

The Veneziano type amplitude is obtained for the process $A_\mu\pi \rightarrow A_\mu\pi$ for all invariant functions. The amplitude satisfies the PCAC equation. The on-mass-shell amplitudes obtained from it are correct up to the leading trajectory. The off-mass-shell amplitude has also the non-Regge behavior at high energies. It does not satisfy the FDGM sum rule if one assumes a general expression for the pion form factor. (auth)

59465 STUDY OF $n\bar{p}$ ANNIHILATION AT REST IN A DUAL MODEL FOR THE $\pi\pi\pi N\bar{N}$-FIVE POINT FUNCTION. Bender, I.; Rothe, Heinz J. (Univ., Heidelberg). Z. Phys.; 247: No. 2, 180-8(1971).

The annihilation of the $n\bar{p}$-system at rest into three pions is discussed within the framework of dual model for the $\pi\pi\pi N\bar{N}$-five point function obtained in previous work. It is shown that with suitable modifications the model is able to describe the experimental data. (auth)

59466 UNITARIZATION, CASTILLEJO–DALITZ–DYSON POLES, AND SCALAR COMPANIONS. Rockmore, Ronald (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., D; 4: No. 3, 900-2(1 Aug 1971).

It is shown how Castillejo–Dalitz–Dyson poles may be introduced into the effective-range formulas for scalar (I = J = 0) $\pi\pi$ and (I = J = $\frac{1}{2}$) $K\pi$ form factors derived from current algebra and a method of pole and cut dominance. The restriction to only two such poles leads to formulas characterized by four free parameters, one of which is conventionally fitted to the zero of the soft-meson s-wave amplitude. In the case of the s-wave $\pi\pi$ phase-shift fit, the remaining three parameters are fixed by requiring the 0^+ resonances, $\epsilon(750)$ and $\epsilon'(1060)$, and the experimentally observed value (in the up-up data) of $\delta_{00}(\pi\pi) \simeq \pi$ at 900 MeV as input. The resulting fit is nearly indistinguishable from the earlier two-parameter fit which uses only the ϵ, over the energy range from threshold to 800 MeV, and is very close to that of the unitarized Lovelace–Veneziano model from threshold to 1060 MeV, although the resonance parameters in the latter fit [$\epsilon(698)$ and $\epsilon'(911)$] differ somewhat. Considerably greater variation in fit is found in the case of the s-wave $K\pi$ phase shift; a qualitative fit to the up-up data of Antich et al. is obtained using $\kappa(900)$, $\kappa'(1600)$, and $\delta_0^{(\frac{1}{2})}(K\pi) \simeq \pi$ at 1000 MeV. (auth)

59467 ANTIBARYON–BARYON SCATTERING PROBLEM. Weiner, Richard M. (Indiana Univ., Bloomington). Phys. Rev., D; 4: No. 3, 813-25(1 Aug 1971).

The implications of the failure of duality in $\bar{B}B$ scattering are discussed in the framework of a quark model in which all quarks of the target interact simultaneously with all quarks in the projectile through two-body quark-antiquark interactions. It is assumed that the peculiarity of $\bar{B}B$ interactions, which at the particle level manifests itself through annihilation channels, is due to the strong $q\bar{q}$ interaction at the quark level which inhibits the presence of nonactive quarks (spectators) in the scattering process. This leads to the replacement of the additivity approach of quark amplitudes by factorization of quark amplitudes. Factorization of quark amplitudes implies, in general, nonfactorization of particle amplitudes and appearance of effects similar to cuts (dips versus peaks in the forward direction) due to the simultaneous exchange of natural and unnatural parity at the quark level. Exchange of exotic quantum numbers appears as a natural consequence of the model, without assuming the existence of exotic particles. It is, however, inhibited by the smallness of charge- and strangeness-exchange cross sections. This model should apply both for large- and small-angle scattering, the difference in these two regions manifesting itself only through different relations between the helicity amplitudes at the quark level. Predictions are made for quasielastic $\bar{B}B$ scattering at small and large momentum transfer. For the reactions where data exist, the agreement between the relations predicted by the model and experiment is satisfactory. (auth)

59468 IMPLICATIONS OF A CHARGE ASYMMETRY IN THE ω^0 DALITZ PLOT. Simmons, W. A.; Tuan, S. F. (Univ. of Hawaii, Honolulu). Phys. Rev., D; 4: No. 3, 663-9(1 Aug 1971).

The possible theoretical implications of the recent evidence for a charge asymmetry in the ω Dalitz plot are analyzed. In particular, the asymmetry is discussed in terms of theoretical models based on (a) the Okubo–Yuta background-interference effect, (b) an interfering mass-degenerate exotic resonance $\bar{\rho}^0(I^G = 1^-, J^{PC} = 1^{-+})$, and (c) C violation in $\rho^0 \rightarrow \pi^+\pi^-\pi^0$ decay with coherence of the ρ^0 and ω^0 production amplitudes. (auth)

59469 CURRENT ALGEBRA AND ANALYTICITY: BOOTSTRAPPING THE ρ AND σ WITH THE PION DECAY CONSTANT SETTING THE SCALE. Brown, Lowell S. (Univ. of Washington, Seattle); Goble, Robert L. Phys. Rev., D; 4: No. 3, 723-5(1 Aug 1971).

Simple one-parameter forms for the S and P waves of pion scattering that obey current-algebra constraints and allow for a resonance are constructed: The parameters are completely determined by solving self-consistently three subtracted forward dispersion relations in a region up to 1 GeV. Resonances for the ρ and σ are produced with the mass scale set by the pion decay constant, but the "exotic" T = 2 S wave is nonresonant. (auth)

59470 ISOBARIC FIVE-POINT FUNCTION AND $\bar{p}p \rightarrow 4\pi$ AT REST. Boguta, J. (Univ., Bonn). Lett. Nuovo Cim.; 2: No. 15, 764-8(9 Oct 1971).

A two-pole isobaric five-point amplitude A_5 was constructed which satisfies a set of planar duality constraints. It is shown that the A_5 amplitude constructed according to the requirements of factorization and anticyclical symmetry makes identical predictions for $\bar{p}p \rightarrow 4\pi$ in the intermediate-energy range as the dual model. (L.B.S.)

Strong (Baryon No. = 1)

Refer also to abstracts 59293 and 59304.

59471 (CEA-N-1456) SPIN AMPLITUDES IN SPIN-$\frac{1}{2}$ SCATTERING. Derem, Andre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1971. 26p. (In French). Dep. NTIS (U. S. Sales Only).

The expression of the various spin amplitudes which are used in the $0^- + \frac{1}{2}^+ \rightarrow 0^- + \frac{1}{2}^+$ scattering is given for the case of four unequal particle masses. The transformation in the experimentally measured physical quantities that occurs when going from one set of amplitudes to another is examined. The determination of the phase of the amplitudes is briefly discussed. (France)

59472 (JINR-P2-6022) STATISTICAL RECONSTRUCTION OF INELASTIC π-N AND N-N INTERACTIONS IN THE SUPERHIGH ENERGY REGION. Barashenkov, V. S.; Eliseev, S. M.; Chigrinov, S. E. (Joint Inst. for Nuclear Research, Dubna (USSR)) 1971. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

Analytical approximations, which allow the characteristics of inelastic π-N and N-N interactions at high and superhigh energies to be reconstructed, are obtained by the Monte-Carlo method and taking into account the energy-momentum conservation law. (auth)

59473 POSITIVE WIDTH AND S-WAVE SCATTERING LENGTH IN $\pi\lambda$ SCATTERING IN VENEZIANO MODEL. Chowdhury, A. Roy; Roy, T. (Jadavpur Univ., Calcutta). Progr. Theor. Phys. (Kyoto); 46: No. 1, 332-3(Jul 1971).

The widths of baryon resonances of positive and negative parity are calculated for the $\pi\Lambda \rightarrow \pi\Lambda$ process. The S-wave scattering length for the $\pi\Lambda$ interaction is also calculated and found to be $\alpha_0 = -0.68$ fm. (L.B.S.)

59474 LOWER BOUNDS ON TOTAL CROSS-SECTIONS FOR MESON–BARYON SCATTERING AND THE MODIFIED POMERANCHUK THEOREM. Saleem, M. (Panjab Univ., Lahore); Mir, Khalid L.; Rafique, M. Progr. Theor. Phys. (Kyoto); 46: No. 1, 334-5(Jul 1971).

The Pomeranchuk theorem was previously modified to give results which are not inconsistent with Serpukhov data. Lower bounds on elastic and charge-exchange cross sections for πN and KN interactions are obtained using the modified Pomeranchuk theorem. (L.B.S.)

59475 ANALYSIS OF THE A_1 AND A_2 REGIONS IN THE REACTION $\pi^-p \rightarrow \pi^+\pi^+\pi^-p$ AT 5 GeV/c. Rinaudo, G. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin); Werbrouck, A. E.; Boeckmann, K.; (and others). Nuovo Cim.; 5A: No. 2, 239-57(21 Sep 1971).

By a thorough analysis of the moments of the angular distributions, evidence is obtained of a wide ($\approx$300 MeV) $\pi\rho$ threshold effect of $J^P = 1^+$, mainly S-wave. Other J^P assignments are improbable. This 1^+-state is produced peripherally, with ρ_{00} close to 1 in the Jackson system, and initial helicity more nearly conserved in the Jackson than in the c.m. helicity system. Evidence for interference between A_1^+ and A_2^+ is found. A detailed discussion of the method of analysis is presented. (auth)

59476 ENERGY DEPENDENT MULTICHANNEL M-MATRIX FITS TO THE AVAILABLE PARTIAL WAVE ANALYSES OF THE KN SYSTEM. Gupta, Madan Lal. Blacksburg, Va.; Virginia Polytechnic Inst. (1971). 193p. University Microfilms Order No. 71-19,344.

Thesis.

A detailed study is made of the available partial wave analyses on the $\bar{K}N$ scattering data with a view to facilitate a multichannel partial wave analysis over an extended momentum range. The scattering amplitudes from all the partial wave analyses to date are calculated and compared under a common set of conventions. Besides giving a comprehensive picture of the behavior of the scattering amplitudes over the momentum range 0 to 1400 MeV/c, this brings out those momentum regions and partial waves that should receive more attention in all future analyses. Further, the high-energy behavior of the $\bar{K}N$ scattering amplitudes is examined by making multichannel M-matrix fits to the best set of scattering amplitudes over the entire momentum range under consideration. Finally, the multichannel M-matrix fits are repeated on the low momentum (0 to 500 MeV/c) scattering amplitudes and parameters obtained that can be used as starting points in a multichannel partial wave analysis on the $\bar{K}N$ scattering data. (Diss. Abstr.)

59477 EMPIRICAL ANALYSIS OF THE DIFFERENCES AND SUMS OF THE KAON-NUCLEON ANGULAR DISTRIBUTIONS. **Matos, James E.** Madison, Wis.; Univ. of Wisconsin (1971). 172p. University Microfilms Order No. 71-16,885.

Thesis.

An empirical analysis of the differences and sums of the kaon-nucleon angular distributions is presented. The Regge pole model is used as a general framework for parameterizing and correlating the data, but the main objective is to obtain results which are model-independent. Analysis of the energy dependences of the differences and sums of the KN charge-exchange (CHEX) cross sections at high energy indicates that the ρ and A_2 are exchange degenerate. At low energies, however, contributions other than (ρ, A_2) exchange are important because the CHEX differences are substantial. The effective trajectory describing the energy dependence of this contribution is determined. The SU(3) CHEX sum rule is shown to work down to 1.25 GeV/c, and angular distributions for the reaction $\pi^-p \rightarrow \eta n$ at 1.6 and 2.3 GeV/c are predicted. Quantitative evidence is presented for the validity of the duality principle. Analysis of the sums of the $K^{\pm}p$ angular distributions gives an effective trajectory whose slope is consistent with the Pomeranchon slope of ~.4 $(\mathrm{GeV}/c)^{-2}$ deduced from high energy pp scattering data and the reaction $\gamma p \rightarrow \varphi p$. The differences of these angular distributions are quantitatively well described by the P-ω interference term, and the ω residue is fit well by the Bessel function J_0. Several zeros of β_ω in addition to the standard zero at $|t| \sim .2\ (\mathrm{GeV}/c)^2$ are predicted. The energy dependence of the first cross-over is determined empirically, and evidence for a second cross-over is presented. Recent data on the reaction $K_2^0p \rightarrow K_1^0p$ at 3 and 6 GeV/c are analyzed utilizing the inter-relation between the $K^{\pm}p$ elastic amplitudes and the regeneration amplitude. The difference between $d\sigma/dt$ $(K_2^0p \rightarrow K_1^0p)$ and the contribution of the ω nonflip amplitude is well represented by the ρ spin-flip contribution. The behavior of the predicted regeneration cross section at large $|t|$ constitutes further evidence for a Pomeranchuk slope of ~½. A technique is presented for examining the relative phase between the Pomeranchuk and ω amplitudes. (Diss. Abstr.)

59478 APPLICATION OF A UNITARIZED VENEZIANO MODEL TO THE REACTION $K^+n \rightarrow K^+\pi^-p$ AT 3 GeV/c. Buchner, K.; Dehm, G.; Goebel, G.; (and others) (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nucl. Phys.; B34: No. 1, 292-306(1971).

A unitarized Veneziano model for $K^+\pi^-$ elastic scattering is combined with the exchange of a Regge pion to describe the reaction $K^+n \rightarrow K^+\pi^-p$ at 3 GeV/c. The resulting distributions for the Kπ mass, the momentum transfer between the nucleons and the Kπ decay density matrix are compared with the experimental data. (auth)

59479 REACTION $\pi^-p \rightarrow \eta n$ AND UNIVERSALITY OF COMPLEX TRAJECTORIES. Zotov, N. P.; Tarasevich, S. V.; Tsarev, V. A. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 14: No. 2, 79-81(20 Jul 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 2, 120-3(20 Jul 1971).

A parametrization based on assumptions of a complex Regge trajectory of the A_2 (at $t > 0$) and universality of the complex trajectory was used to analyze the experimental data on the reaction $\pi^-p \rightarrow \eta n$, and was found to satisfy the polarization and differential cross section data. (L.B.S.)

59480 APPLICATION OF A DUAL DIFFRACTIVE MODEL TO THE REACTION $\pi^+d \rightarrow d\pi^+\pi^+\pi^-$ AT 13 GeV/c. Paler, K.; Badewitz, R. C.; Barton, H. R. Jr.; (and others) (Purdue Univ., Lafayette, Ind.). Nucl. Phys.; B33: No. 1, 13-21(1971).

A dual diffractive model is applied to the reaction $\pi^+d \rightarrow d\pi^+\pi^+\pi^-p$ at 13 GeV/c. The model is based on that used to describe the reaction $K^-p \rightarrow K^-\pi^+\pi^-p$ at 10 GeV/c. For this π^+d reaction there are a smaller number of free or quasi free parameters, due to Bose-symmetry, than in the K^-p reaction. In addition, the basic assumption of the model, which is the dominance of a diffractive production mechanism, is well satisfied. Reasonable overall agreement is obtained at 13 GeV/c but the predicted energy dependence of this reaction is not in agreement with experimental data. (auth)

59481 INVARIANT AMPLITUDES OF PION–NUCLEON SCATTERING IN THE UNPHYSICAL REGION FOR $t \leq 4\mu^2$ AND HELICITY AMPLITUDES. Nielsen, H. (Univ. of Aarhus, Denmark). Nucl. Phys.; B33: No. 1, 152-64(1971).

Tables of pion-nucleon invariant amplitudes in the unphysical region $-25\mu^2 \lesssim t \leq 4\mu^2$ and $|\cos\theta_s| > 1$ are presented. The tabulated values were found from fixed t-dispersion relations and they are compared with results obtained by analytic continuation of the dispersive part for fixed energy. Finally, tables are given for the t-channel helicity amplitudes in the above mentioned interval. The system of units where $\hbar = c = \mu = 1$ was used. (auth)

59482 EXPERIMENTAL TEST OF SEMI-LOCAL DUALITY IN $K^-p \rightarrow \bar{K}^0n$ BACKWARD SCATTERING. Bricman, C.; Pagiola, E.; Schmid, C. (CERN, Geneva). Nucl. Phys.; B33: No. 1, 135-8(1971).

$K^-p \rightarrow \bar{K}^0n$ backward scattering is exotic at high energy and should exhibit a cancellation of the strong Y* resonances at low energies. Experiment shows that there is a semi-local cancellation between adjacent energy intervals (spaced by 1 GeV^2) rather than a local cancellation between parents and daughters. (auth)

59483 REGGE CUT CONTRIBUTIONS TO EXOTIC BOSON EXCHANGE CROSS SECTIONS. **Quigg, C. (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Nucl. Phys.; B34: No. 1, 77-91(1971).**

Explicit calculations of near-forward differential cross sections for the single-particle-exchange forbidden reactions $\bar{K}N \rightarrow K\Xi$, $K^-p \rightarrow \pi^+\Sigma^-$, and $\pi^-p \rightarrow K^+\Sigma^-$ are reported. The predictions are based upon an absorptive prescription for Regge cuts which satisfies s-u crossing. Characteristic properties of Regge-cut models are identified and suggestions are made for experimental studies. (auth)

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59484 CALCULATIONS OF LOW ENERGY πd REACTIONS. Beder, Douglas S. (Univ. of British Columbia, Vancouver). Nucl. Phys.; B34: No. 1, 189-99(1971).

The impulse approximation is used to calculate differential cross sections at 40 and 60 MeV (lab K.E. of π^+) for the reactions $\pi^+d \rightarrow \pi^+d$ and $\pi^+d \rightarrow \pi^+np$. Comparison with experiment should be useful to further general understanding of π-nucleus processes, and therefore low-energy experiments in this unexplored area are encouraged. (auth)

59485 GENERALIZED POTENTIAL AND UNIQUENESS IN THE CALCULATION OF THE PION–NUCLEON P_{33} STATE. Engels, J.; Frank, V. (Univ., Karlsruhe, Ger.). Nucl. Phys.; B22: No. 2, 429-47(1970).

Two different iteration procedures are used to calculate the P_{33} phase shift of pion-nucleon scattering: a modified N/D method and the Newton–Kantorovich method. It is possible to find the correct generalized potential for the P_{33} partial wave amplitude from threshold up to $T_\pi = 870$ MeV without using the P_{33} phase shift. With this input the iterations converge exactly to the phase-shift analysis values only if two parameters are introduced. It turns out that the output phase shift is very sensitive to small variations in the potential. Since parameters have to be used it is concluded that in the usual N/D method a solution is only possible if one includes at least one CDD pole. (auth)

59486 DYNAMICAL MODEL FOR THE πN RESONANCE $S_{11}(1525)$. Gustafson, Goesta (NORDITA, Copenhagen). Nucl. Phys.; B22: No. 2, 605-24(1970).

A dispersion theoretic model is developed which explains the behavior of the $\pi N \rightarrow \eta N$ cross section and the loop in the Argand diagram for the S_{11} phase shift in πN scattering. It also explains the very strong energy dependence of the S_{11} amplitude below and close to the η-threshold. The amplitudes have a singularity below threshold at approximately 1420 MeV, on sheet IV. The phenomenon is mainly due to the exchange of a pair of π-mesons in a state with $I = J = 0$ in the channel $\eta N \rightarrow \eta N$. The same method should also be applicable to other reactions, and some general properties of scattering amplitudes close to an inelastic threshold are discussed. (auth)

59487 PARITY VIOLATION IN πN SCATTERING. McKellar, Bruce H. J.; Pick, Peter (Univ. of Sydney). Nucl. Phys.; B22: No. 2, 625-36(1970).

The possibility of detecting the $\Delta S = 0$ weak interaction by observing the longitudinal polarization of the recoil nucleon in πN scattering is considered. It is found that the longitudinal polarization is in the range 10^{-6} to 10^{-7}, which seems to be beyond the capabilities of the experimental techniques of the immediate future. (auth)

59488 CROSSING AND ISOSPIN SYMMETRIC DESCRIPTION OF THE $\bar{K}N$ $\pi\pi\bar{\Lambda}$ SYSTEM USING THE GENERALIZED VENEZIANO MODEL. Hoyer, P. (CERN, Geneva); Petersson, B.; Toernqvist, N. A. Nucl. Phys.; B22: No. 2, 497-511(1970).

The Veneziano five-point function model, applied previously to $K^-p \rightarrow \pi^-\pi^+\Lambda$, is used to describe four other reactions which are related to $K^-p \rightarrow \pi^-\pi^+\Lambda$ by crossing and isospin symmetry. It is found that with no new parameters a global description of the five different processes can be obtained. (auth)

59489 S- AND P-WAVE K^+p SCATTERING BELOW 600 MeV/c. Martin, B. R.; Thompson, G. D. (University Coll., London). Nucl. Phys.; B22: No. 1, 285-300(1970).

Values for the s-wave K^+p scattering length and curvature coefficient are obtained by extrapolating the low-energy amplitude to threshold using a parameteric form derived from a forward dispersion relation. In addition, a calculation of the p-wave scattering lengths from forward dispersion relation sum rules is presented. The calculations are performed in an iterative manner starting from the pure s-wave solution of Goldhaber et al. (auth)

59490 DUAL + POMERON ANALYSIS OF $K^\pm p \rightarrow K^\pm\pi^0p$. Kajantie, K.; Papageorgiou, S. (CERN, Geneva). Nucl. Phys.; B22: No. 1, 31-44(1970).

Data for $K^\pm p \rightarrow K^\pm\pi^0p$ are analyzed in terms of a model containing a dual five-point amplitude added to a model amplitude for the diffraction dissociation process $K^\pm p \rightarrow K^\pm N^*$. The magnitudes of these amplitudes are estimated by connecting them to those of previously analyzed $KN \rightarrow K\pi N$ reactions by isospin and by factorization, respectively. Clear evidence for a considerable (≈50% at 10 GeV/c) Pomeron contribution is found and a satisfactory overall description of the data is given. The reasons for the discrepancies on a detailed level are inherent to the model. (auth)

59491 FIT OF BARYON DECAY RATES WITHIN SU(3). Plane, D. E. (CERN, Geneva); Baillon, P.; Bricman, C.; (and others). Nucl. Phys.; B22: No. 1, 93-108(1970).

A test of the consistency between observed resonant amplitudes or decay rates for baryon resonances with SU(3) predictions was made. Coupling constants describing the decays are determined and predictions are given for decays into stable baryons and mesons. (auth)

59492 GENERALIZED VENEZIANO MODEL FOR $\pi^-p \rightarrow K^0\bar{K}^0n$. Collins, P. A.; Hartley, B. J.; Moore, R. W.; Moriarity, K. J. M. (Imperial Coll. of Science and Tech., London). Nucl. Phys.; B22: No. 1, 150-6(1970).

The model proposed by Petersson and Törnqvist is applied to the process $\pi^-p \rightarrow K^0\bar{K}^0n$ at 12 GeV/c. The results are compared with the data used by Chan et al. in an application of a double Regge model to this process. (auth)

59493 CONSISTENCY CONDITIONS BETWEEN SU(3) AND EXCHANGE DEGENERACY FOR MESON–BARYON SCATTERING. Rimpault, M.; Salin, Ph. (Faculte des Sciences, Bordeaux). Nucl. Phys.; B22: No. 1, 235-46(1970).

Non-exotic solutions for meson-baryon scattering amplitudes compatible with exact SU(3) symmetry and exchange degeneracy are presented and discussed. It is shown that there exist dual solutions, i.e. solutions which reproduce themselves under crossing from one channel to the others. The physical consequences predicted by these solutions are also investigated. (auth)

59494 ASYMPTOTICAL PROPERTIES OF THE $K_L^0 + p \rightarrow K_S^0 + p$ AMPLITUDE. Nguyen Van Hieu. Teor. Mat. Fiz.; 8: No. 3, 354-8(Sep 1971). (In Russian).

The relation between the real and imaginary parts of the amplitude of the reaction $K_L^0 + p \rightarrow K_S^0 + p$ at high energies ($s \rightarrow \infty$) and $t = 0$ is investigated. (auth)

59495 COMPLEX REGGE POLES IN πN BACKWARD SCATTERING. Gregorich, David T. (California State Coll., Los Angeles); Kaus, P.; Park, Robert T. Phys. Rev., D; 4: No. 3, 834-40(1 Aug 1971).

The structure of the pole-cut combination in πN backward scattering is represented by a complex N_α and Δ_δ pair. For negative u, these are not complex conjugate but rather each pair splits into a steep (normal) and a flat trajectory. There are no MacDowell partners and each steep trajectory would produce the usual baryon spectrum at positive u and the steep N_α is mainly responsible for the dips at $u \approx -0.2$ through wrong-signature nonsense zeros. The trajectories are generated by a D function which has a fixed cut with square-root singularity at the branch point. Excellent fits were obtained for πN elastic and charge-exchange differential cross sections in the backward direction. (auth)

59496 INELASTIC PION–NUCLEON INTERACTIONS WITH HIGH MULTIPLICITY AND THE ONE-PION EXCHANGE MODEL. Azimov, S. A.; Beter, E. V.; Gulyamov, U. G.; Lebin, A. Ya. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz.; 14: No. 1, 240-6(Jul 1971). (In Russian).

The model of one-pion exchange for inelastic collision $\pi + N \rightarrow n\pi + N$ with any (odd) number of secondary pions is proposed. The effective mass spectrum of the secondary pion system is obtained in the analytical form convenient for calculations. The comparison of calculation with the experimental data available at different initial energies shows a satisfactory agreement of the proposed model with the experiment. (auth)

59497 STRUCTURE OF SCATTERING AMPLITUDES AND INELASTIC PROCESS AMPLITUDES IN PRE-ASYMPTOTIC REGION. Anisovich, V. V.; Kistenev, Z. P.; Kobrinskii, M. N. (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 14: No. 2, 441-53(Aug 1971). (In Russian).

Arguments are given that the asymptotic regime in the angular distributions of the scattering processes must occur only at extremely high energies: $E_{l.s.} \gg 20$ GeV for the pion–nucleon collisions and at $E_{l.s.} \gg 100$ GeV for the nucleon–nucleon collisions. (auth)

59498 RECONSTRUCTION OF AMPLITUDES FOR PION–NUCLEON SCATTERING FROM EXPERIMENTAL DATA. Giffon, M.; Joseph, J.; Meyer, J. (Univ., Lyon). Nuovo Cim.; 5A: No. 3, 478-94(1 Oct 1971).

The possibility of using experimental data to reconstruct the energy and angular dependence of the amplitudes for pion–nucleon scattering without the use of any specific model is explored. It is shown that one can reasonably hope to solve this problem for the near forward scattering. (auth)

59499 ANALYSIS OF THE REACTION $\pi^+p \rightarrow \rho^0\Delta^{++}$ AT 11.7 GeV/c INCIDENT MOMENTUM. II. AN INTERPRETATION IN TERMS OF REGGE-POLE EXCHANGE. Maddock, R. O. (Univ. of Durham, Eng.); Pinter, G. F.; Caso, C.; (and others). Nuovo Cim.; 5A: No. 3, 457-77(1 Oct 1971).

A model-independent analysis is made to determine the relative contribution of natural and unnatural parity exchange in the reactions (1) $\pi^+p \rightarrow \rho^0\Delta^{++}$ at 11.7 GeV/c and (2) $\pi^-p \rightarrow \rho^0n$ at 11 GeV/c. A simple evasive Regge-pole model with only π-trajectory exchange was applied to the data of reaction (1) and then to the combined data of reactions (1) and (2). A satisfactory fit to the data is obtained. The parameters determined in fitting reaction (1) were used to make predictions for the same reaction at 8, 13.1 and 18.5 GeV/c. A comparison with experimental data at these momenta was made. Considering the severe nature of this test for the evasive model there is altogether satisfactory agreement between the predictions and the data. (auth)

59500 NEW TYPE OF BARYON RESONANCES. Dal'karov, O. D.; Kerbikov, B. O.; Mandel'tsveig, V. B.; Shapiro, I. S. JETP Lett. (USSR) (Engl. Transl.); 14: No. 3, 127-9(5 Aug 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 3, 191-4(5 Aug 1971).

A potential approach is used to investigate quasinuclear bound states of the $2N\overline{N}$ system. The energy spectrum and wave functions of this system are studied, and results of the calculation of the spectrum of levels for states with $I(J^P) = 3/2(5/2^+)$ are given. The binding energy is also calculated. It is concluded that sufficiently narrow bound quasinuclear states exist in the three-particle system $2N\overline{N}$. The quasinuclear model thus predicts a new type of baryon resonances. The results also make quite likely the hypothesis of the existence of quasinuclear systems of the type $2N2\overline{N}$, which could appear as boson resonances with isospin $I \leq 2$ and masses in the interval 2500 to 3500 MeV. (J.F.P.)

59501 EVIDENCE ON DUALITY AND EXCHANGE DEGENERACY FROM FINITE-ENERGY SUM RULES: $K^-n \rightarrow \pi^-\Lambda$ AND $\pi^+n \rightarrow K^+\Lambda$. Field, R. D. Jr.; Jackson, J. D. (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 3, 693-709(1 Aug 1971).

Using finite-energy sum rules for the reactions $K^-n \rightarrow \pi^-\Lambda$ and $\pi^+n \rightarrow K^+\Lambda$, the effective "pole" parameters of the K^* and K^{**} Regge trajectories from a knowledge of the low-energy resonances and their couplings are determined. The resonance parameters and the D/(D + F) ratio for the $1/2^+$ baryon octet are varied somewhat to test the sensitivity of the high-energy predictions; $1/2^+$ octet couplings within the range of values found empirically in other reactions are preferred in our solution. It is found that the s-channel resonances in $K^-n \rightarrow \pi^-\Lambda$ do add in such a way as to produce predominantly real amplitudes at high energies as predicted by duality diagrams. It is found, however, that these predictions are not satisfied exactly. Although the phases of both A′ and B are small and independent of t for $|t| < 0.5$ $(GeV/c)^2$, the residues of the even- and odd-signature Regge poles are closely exchange-degenerate only for the B amplitudes, and not for the A′ amplitudes, thereby allowing an appreciable polarization for $K^-n \rightarrow \pi^-\Lambda$ as is observed experimentally. The Regge-pole parameters determined from the sum rules give a good fit to the reaction $K^-n \rightarrow \pi^-\Lambda$ over a wide range of energies, whereas they are unable to fit $\pi^+n \rightarrow K^+\Lambda$ at intermediate energies. Comparison of the resonance contributions to $K^-n \rightarrow \pi^-\Lambda$ and $\pi^+n \rightarrow K^+\Lambda$ shows that "peripheral" resonances dominate the sum rules in the first reaction, while "nonperipheral" states are important in the second. By supposing that "peripheral" resonances are dual to the leading Regge singularities in the t channel, while "nonperipheral" resonances are dual to lower-lying singularities, a rationale of why the simple model of two effective Regge poles is adequate for $K^-n \rightarrow \pi^-\Lambda$ even at intermediate energies, but inadequate there for $\pi^+n \rightarrow K^+\Lambda$ is obtained. (auth)

59502 ROTATION OF THE SYMMETRY AXIS IN K-π SCATTERING. Slater, W. E. (Univ. of California, Los Angeles). Phys. Rev., D; 4: No. 3, 709-17(1 Aug 1971).

The failure of the Treiman–Yang test of one-pion exchange in the reactions $K^+p \rightarrow K^0\pi^0\Delta^{++}$ and $K^+\pi^-\Delta^{++}$ for c.m. energies from 2.5 to 5.0 GeV is shown to have a simple dependence on t′. An empirical dynamic z axis with respect to which the K-meson angular distributions are independent of azimuth is found. This axis, which depends on t′, is seen to be equivalent to the axis of Donohue and Högaasen in the neighborhood of the $K^*(0.89)$. (auth)

59503 POLARIZATION IN $0^-1/2^+ \rightarrow 0^-1/2^+$ CHARGE AND HYPERCHARGE EXCHANGE REACTIONS AT INTERMEDIATE ENERGIES. O'Donovan, P. J. (Univ. of Colorado, Boulder. Arizona State Univ., Tempe). Lett. Nuovo Cim.; 2: No. 15, 737-42(9 Oct 1971).

Within the framework of Regge pole theory with strong exchange degeneracy and cuts, the leading nonasymptotic Regge contribution—double Regge-pole exchange—to meson-baryon single-charge and hypercharge exchange reactions is considered. It is found that the polarization predictions from double-Regge-pole exchange are correct provided that the f/d ratios of the vector–tensor couplings to the baryon octet are restricted to a certain range of values. (L.B.S.)

59504 DUAL STRUCTURE OF $\overline{K}N$ SCATTERING IN THE INTERMEDIATE ENERGY REGION. Fukugita, M. (Tokyo Univ.); Inami, T.; Kimura, Y. Phys. Lett.; 36B: No. 6, 575-8 (18 Oct 1971).

The "two component theory" of duality was tested by constructing the $I_t = 0$ and $I_t = 1$ combinations of the s-channel helicity amplitudes from the new $\overline{K}N$ partial wave solutions given in the form of the sum of nonresonating background and resonance parts. The background amplitudes have properties perfectly consistent with the Harari–Freund conjecture. The resonance amplitudes exhibit the t-dependence indicative that the Regge exchange picture, including the s-channel helicity nonflip and flip characters of the $\omega - f$ and $\rho - A_2$ exchanges, persists even at $p_L \approx 1.0$ GeV/c. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 59278, 59701, 59707, and 59712.

59505 (JINR–E2-6031) PHENOMENOLOGICAL STUDY OF INCLUSIVE SINGLE PARTICLE SPECTRA IN THE TRIPLE REGGE LIMIT. Ranft, G.; Ranft, J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 23p. Dep. NTIS (U. S. Sales Only).

Inclusive single particle spectra of $\pi^\pm$, $K^\pm$, p and $\overline{p}$ produced in pp collisions at 14.25, 19.2, 24 and 70 GeV/c are studied with the triple Regge formula. Good fits are obtained indicating that this formula describes well the S, M* and t-dependence of these data. The Regge parameters obtained in the fit differ however from the ones expected from two-body reactions and change only slightly in the expected sense with increasing primary energy. It is argued therefore that no conclusion regarding the physical significance of the triple Regge term should be drawn from the success of such fits at present energies. (auth)

59506 (JINR–E15-5905) DETERMINATION OF THE NEUTRON–NEUTRON SCATTERING LENGTH FROM A KINEMATICALLY COMPLETE EXPERIMENT WITH THE REACTION $^3H(t,n\,^4He)n$. Kuehn, B.; Kumpf, H.; Parzhitskii, S.; Tesch, S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1971. 23p. Dep. NTIS (U. S. Sales Only).

In a two-dimensional measurement the energies of the alpha particle and one neutron from the reaction $^3H(t,n^4He)n$ were analyzed. The angles were chosen so as to observe the n–n final state interaction near zero relative energy of the two neutrons. From a comparison of the data with Born approximation a value $a_{nn} = (-15.0 \pm 1.0)$ fm for the $^1S_0$ scattering length was obtained. Analogous experiments with the mirror reaction $^3He(^3He,p^4He)$ and with $^3He(t,p^4He)$ yielded $a_{pp} = (-7.6 \pm 0.6)$ fm and $a_{np}^{s} = (-21 \pm 3)$ fm for the singlet scattering lengths. Their agreement with known values demonstrates the possibility of obtaining a reliable value of a_{nn}. (auth)

59507 (ORNL–4673) CALCULATION OF THE NUCLEON- AND PION-INDUCED STAR AND FLUX DISTRIBUTIONS FROM 400-GeV PROTON INTERACTIONS IN IRON. Santoro, R. T.; Gabriel, T. A. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 27p. Dep. NTIS.

Monte Carlo calculations were made to estimate the nucleon- and pion-induced star and flux distributions from the interactions of 400-GeV protons in iron. Laterally integrated and radially dependent star distributions as a function of depth in the iron are presented. Omnidirectional nucleon and charged-pion fluxes and energy-dependent flux distributions are also included. (auth)

59508 (ORNL-tr-2514) INTERACTION OF HIGH-ENERGY RADIATION WITH MATTER. Barashenkov, V. S.; Sobolevskii, N. M.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated for Oak Ridge National Lab., Tenn., from report JINR–P2-5719. 11p. Dep. NTIS.

This item was previously abstracted from the original language and appeared in NSA as 25: 36816. (auth)

59509 ELASTIC SCATTERING OF HIGH-ENERGY PROTONS ON NUCLEI. Gabrakov, S. I.; Petkov, I. Z. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 24: No. 4, 447-9(1971).

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Effective cross sections are calculated for the elastic scattering of 1-GeV protons on oxygen-16. (J.F.P.)

59510 NEW DEFINITION OF THE THREE-BODY SEPARABLE POTENTIAL AND ITS APPLICATION TO THE THREE-NUCLEON SYSTEM. **Oryu, Shinsho (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 1, 350-2(Jul 1971).**

A new three-body separable potential is proposed as is applied to quasi-elastic and inelastic scattering. The results for the scattering amplitudes are in good agreement with the exact theory. (L.B.S.)

59511 FLAT PROTON SPECTRUM AND ITS IMPLICATIONS. Hwa, Rudolph C.; Lam, C. S. **(State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev. Lett.; 27: No. 16, 1098-1101(18 Oct 1971).**

The longitudinal momentum distribution of the final detected proton in pp inclusive reactions is flat for energies ranging from 20 to 1500 GeV. How this can be understood in the diffractive model and how this information provides a way for calculating the average multiplicity and the pion longitudinal momentum distributions in pp inclusive reactions are shown. No arbitrary parameter is used. The agreement with experiment is remarkably good. (auth)

59512 MULTIPARTICLE PRODUCTION MODEL WITH CHARGE CONSERVATION. **Ballestrero, A.; Giovannini, A.; Nulman, R.; Predazzi, E. (Univ., Turin. Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cim.; 5A: No. 2, 197-223 (21 Sep 1971).**

A charge conservation model is discussed which is the generalization of a model proposed earlier. This model, which at the present stage is, inherently, a mechanism for multiple production of soft particles, is compared with experiments. Within the expected limitations of applicability, the model gives rather encouraging results. (auth)

59513 EXTENSION OF THE CHOU-YANG MODEL TO INCLUDE SPIN. **Konig, Edward. New York; City Univ. of New York (1971). 88p. University Microfilms Order No. 71-20,944.**
Thesis.

A model for the elastic scattering of protons by protons proposed by Chou and Yang is extended in a natural way to include spin, the eikonal becoming an operator in spin space. The extended model predicts that the differential cross section for elastic scattering at infinite energies has structure similar to that observed at current energies, but that no true zeroes occur in the cross section at the position of the "breaks." The structure is due to one or more of the five amplitudes for proton-proton scattering rising abruptly from a true zero. (Diss. Abstr.)

59514 ANALYSIS OF DEUTERON REACTIONS USING AMPLITUDES WITH ANOMALOUS THRESHOLDS. **Hicks, Harry Richard. Urbana, Ill.; Univ. of Illinois (1971). 101p. University Microfilms Order No. 71-21,140.**
Thesis.

Various models for relating the amplitude for $X_1 + d \rightarrow X_2 + d$ to the amplitude for $X_1 + N \rightarrow X_2 + N$ are compared. Traditional methods are either static models or involve a 3-momentum integral (folded models). In both cases, some assumption is made regarding the energy of the nucleon subreaction. In the former case an assumption is also made about the 3-momentum of the nucleon reaction. Various such prescriptions for energies near d*, i.e., N* + N, enhancements are tested. These kinematically ambiguous models are then compared to the box graph model (BGM) which is derived using dispersion relations. The BGM has other defects but no kinematic ambiguity. It is theoretically interesting because for these reactions there is a dramatic singularity structure. Using the Hulthén wave function and an impulse model with a simple rescattering prescription, it is found that two of the models agree to within 2% for any physical situation—a BGM and a folded model. From this it is concluded that in a folded model the best energy prescription is to put the spectator nucleon on the mass-shell. The $\gamma + p \rightarrow \eta + p$ was reanalyzed, and no evidence was found for any resonances other than the $S_{11}(1530)$ below $k_{LAB} = 1$ GeV/c. This result is used in analyzing $\gamma + d \rightarrow \eta + d$. The theoretical fit for this reaction is very model dependent. The data are best fit with the 2 models which agree. The ω exchange and S_{11} contributions are found to be present. (Diss. Abstr.)

59515 INVESTIGATION OF CHARGE-SYMMETRY-BREAKING IN THE LAMBDA-NUCLEON INTERACTION. **Sullivan, Edmund Joseph Jr. Kingston, Rhode Island; Univ. of Rhode Island (1970). 130p. University Microfilms Order No. 71-21,836.**
Thesis.

In an attempt to delimit the size of a phenomenological charge-symmetry-breaking (CSB) term in the lambda-nucleon (Λ-N) interaction, S-wave, separable, rank-2 potentials are employed in fitting 2-, 3- and 4-baryon hypernuclear data. Rank-2 potentials allow a study of the effects of short-range N-N and Λ-N repulsions upon the Λ-N CSB singlet and triplet interaction strengths. In addition, a new rank-1 approximation to rank-2 potentials was developed and is applied to the same data. This approximation, called the UPAA, is closely related to the unitary pole approximation. The UPAA is seen to be reasonably accurate in many of the calculations of the structure of ${}_{\Lambda}H^3$ performed in this investigation. Large numbers of good χ^2 fits to the low energy Λ-p scattering data are obtained, which cover a range of scattering length ratios $1 \lesssim a_s/a_t \lesssim 5$. These potentials are then required to fit the Λ-separation energy in ${}_{\Lambda}H^3$ (which is labeled as B_{Λ}) by exact solution, and be consistent with partial information concerning the phenomenological CSB effect in ${}_{\Lambda}He^4$ and ${}_{\Lambda}H^4$. Isospin mixing in ${}_{\Lambda}H^3$ is explicitly included. Prior to the ${}_{\Lambda}H^3$ calculation, an independent analysis was performed in order to provide an effective N-N interaction which is consistent with the ${}^1So$ phase shift, the deuteron binding energy and charge form factor and the singlet and triplet effective range parameters. The results of the analysis indicate that CSB can cover a large range of values and still be consistent with the experimental data. The CSB strength can be expressed as a percentage of the total Λ-p interaction. The range of magnitudes of CSB singlet (0-23%) and triplet (0-14%) found is strongly correlated with the range of values allowed for B_{Λ} and a_s/a_t by existing data. Comparison with some results of prior calculations, which used purely attractive potentials, suggests that the repulsive Λ-N interaction tends to reduce the CSB interaction strengths needed to fit the data. Two results of these prior calculations persist in the present analysis: Isospin mixing in ${}_{\Lambda}He^3$ sometimes produces significant adjustments of CSB strengths. Also, the Λ-N CSB term producing the mass splitting between ${}_{\Lambda}He^4$ and ${}_{\Lambda}H^4$ includes, for a large proportion of the data fits, large cancellations between singlet and triplet Λ-N CSB potentials. (Diss. Abstr.)

59516 CALCULATION OF THE PION-NUCLEUS OPTICAL POTENTAL. **Dover, C. B. (Institut de Physique Nucleaire, Orsay, France); Ballot, J. L.; Lemmer, R. H. Lett. Nuovo Cim.; 2: No. 14, 715-18(2 Oct 1971).**

The two-nucleon absorption and dispersion corrections to the pion-nucleus optical potential are evaluated using realistic nucleon-nucleon potentials which fit NN phase shifts and the properties of the deuteron. The results are compared with the empirical potential obtained by Krell and Ericson. (L.B.S.)

59517 SEPARABLE POTENTIALS IN TWO-, THREE-, AND INFINITE-NUCLEON SYSTEMS. **Serduke, Franklin James David. Davis, Calif.; Univ. of California (1970). 179p. University Microfilms Order No. 71-20,408.**
Thesis.

Separable potentials are a calculationally convenient manner of representing the two-nucleon data. A formalism is presented for the application of such potentials to nuclear calculations. Existing "realistic" separable potentials are shown to saturate nuclear matter at too large a density with too much binding. This result and a determination of the deuteron properties for these potentials indicate that they all fail to provide an adequate representation of the simultaneously bound and coupled ${}^3S_1$-${}^3D_1$ state. Some even fail to bind the deuteron properly; noteworthy among these is the Tabakin potential which predicts a deuteron binding energy of 1.183 MeV. The shortcoming common to all existing "realistic" separable potentials is their weak tensor force; the cause of this deficiency is uncovered and is shown to be correctable. Using a newly constructed set of "model" potentials, it is found that the tensor force is critically important in determining the nuclear matter saturation properties for a given nucleon-nucleon interaction. It is demonstrated contrary to a popularly held view, that "equivalent" local and separable potentials do predict nearly identical binding energies for a model trinucleon. The neglect of the S′ component of the triton's ground state is shown to be a poor and unreliable approximation for determining the binding energy. Off-shell effects in a spin-dependent three-nucleon bound state are found to be small for a set of potentials which have a large variation in their off-shell scattering amplitudes. (Diss. Abstr.)

59518 BINDING ENERGY OF THE SINGLET DEUTERON. **Hare, M. G.; Papini, G. (Univ. of Saskatchewan, Regina). Nucl. Phys.; B34: No. 1, 200-8(1971).**

A method recently developed by the authors to calculate nuclear binding energies is here applied to the singlet state neutron–proton pair, and indicates that the system is unbound. The method makes use of once subtracted dispersion relations for the mass-energy form factors for the separate nucleons and the singlet deuteron, using the sidewise approach, and it assumes threshold dominance. The binding energy is calculated in terms of electromagnetic effects and the effects of the breakup of the singlet deuteron. This last contribution is found to dominate the results. (auth)

59519 PREDICTIONS FOR ELASTIC AND INELASTIC NUCLEON–NUCLEUS CROSS SECTIONS AT HIGH ENERGIES. **Trefil, J. S. (Univ. of Virginia, Charlottesville). Nucl. Phys.; B34: No. 1, 109-16(1971).**

The effect of intermediate resonance production on particle-nucleus cross sections is discussed for particle energies in the energy range up to 1 TeV. It is shown that from present cosmic ray data in pp inelastic cross sections, a decrease in the total and inelastic cross sections for p-nucleus scattering of less than 10% can be expected in this energy range provided that σ_{pp} is constant. Effects of increases in σ_{pp} are discussed. It is shown that the decrease in the inelastic cross section is much smaller, and hence the inelastic cross section cannot be used to probe the high mass hadron spectrum. (auth)

59520 USE OF NNγ DATA FOR NN PHASE SHIFTS. McGuire, J. H. (McGill Univ., Montreal). Nucl. Phys.; B33: No. 1, 281-4 (1971).

Nucleon–nucleon bremsstrahlung data in the soft photon region may be used in fitting the elastic NN phase shifts. Such data provides information about elastic phase shifts over a range of energies. A simple illustration of the usefulness of the NNγ data is provided at 99 MeV where there is a discrepancy between theory and experiment. (auth)

59521 MULTIBARYON RESONANCES WITH B > 5 IN THE MODEL WITH EXCHANGE Δ–N INTERACTION. Karmanov, V. A. (Moscow Engineering Physics Inst.). JETP Lett. (USSR) (Engl. Transl.); 14: No. 2, 84-7(20 Jul 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 2, 127-31(20 Jul 1971).

Multibaryon resonances consisting of the Δ isobar and A nucleons are considered in a model with Δ–N exchange potential. The interaction of the Δ isobar with $4 < A < 16$ nuclei is investigated using the Schroedinger equation. It is found that the attraction between the Δ and the nucleus is not sufficient for the formation of the bound state, and therefore the probability for existence of resonances in the system (ΔAN) with $A > 4$ is low. (L.B.S.)

59522 MASS SPECTRUM OF (Λp) FROM THE REACTION $K^-d \to \pi^-\Lambda p$. Kudryavtsev, A. E. JETP Lett. (USSR) (Engl. Transl.); 14: No. 2, 90-1(20 Jul 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 14: No. 2, 134-7(20 Jul 1971).

The mass spectra of the Λp system from the reaction $K^-d \to \pi^-\Lambda p$ at rest is investigated near the 2130 MeV region. An attempt is made to explain the maximum located at the threshold of the $\Lambda p \to \Sigma N$ reaction as being due to the interaction in the final state. It is concluded that to describe the 2130-MeV peak in the (Λp) mass spectra there is no need to introduce a (Λp) resonance; an estimate of the $\Sigma N \to \Lambda p$ reaction amplitude based on the study of the entire Λp mass spectrum shows that the $\Lambda p \to \Sigma N$ amplitude at threshold has the same order of magnitude as the Λp elastic scattering length. (L.B.S.)

59523 ELASTIC AND SINGLE-CHARGE-EXCHANGE SCATTERING OF PIONS BY CARBON NUCLEI. **Bjoernenak, K. (Univ., Trondheim, Norway); Finjord, J.; Osland, P.; Reitan, A. Nucl. Phys.; B22: No. 1, 179-88(1970).**

The differential cross sections for the reactions $^{12}C(\pi^-,\pi^-)^{12}C$ and $^{13}C(\pi^+,\pi^0)^{13}N$ are calculated in the Glauber approximation for pions with kinetic energies in the 180 MeV region. It is found that the first terms in the Glauber expansion are not convergent, due to the large pion–nucleon resonance amplitude. The Fermi motion of the nucleons in the target nucleus and the exchange terms due to the anti-symmetry of the nuclear wave function have a large influence on the results. (auth)

59524 SIMPLE RELATIONS AMONG MULTIPLE SCATTERING AMPLITUDES IN LIGHT NUCLEI. **Friar, J. L. (Univ. of Washington, Seattle); Dean, N. W. Nucl. Phys.; B22: No. 2, 567-72(1970).**

It is shown that the amplitudes for multiple scattering in nuclei with $A \leq 4$ are related in a very simple way. It is therefore possible to calculate explicitly the contribution of double and triple scattering to the $\pi^{\pm\,4}$He total cross section if the $\pi^{\pm\,3}$He and $\pi^{\pm}$p total cross sections are also known, without the need of fitting the differential cross sections. These contributions contain information about Regge cuts as well as the nuclear structure. (auth)

59525 EVALUATION OF THE LOW-ENERGY ΣN INTERACTION PARAMETERS: POSSIBLE EXISTENCE OF ΣN VIRTUAL BOUND STATE. Gell, Yakov; Alexander, Gideon; Stumer, Iuliu (Tel Aviv Univ., Ramat Aviv, Israel). Nucl. Phys.; B22: No. 2, 583-93(1970).

The low-energy ΣN interaction parameters was evaluated in a fit to the existing experimental data using the K-reaction-matrix formalism. Using these parameters the behavior of the elastic Λp scattering below the ΣN threshold is studied. (auth)

59526 BINDING ENERGY OF THE DEUTERON. Hare, M. G.; Papini, G. (Univ. of Saskatchewan, Regina, Can.). Phys. Rev., D; 4: No. 3, 684-93(1 Aug 1971).

The binding energy of the deuteron is written in terms of once-subtracted, sidewise dispersion relations for the mass-energy form factors of the neutron, proton, and deuteron. The threshold region is assumed to dominate, and accordingly a cutoff is introduced into the dispersion integrals. This cutoff is, however, related to the proton–neutron mass difference δM, so that no free parameter exists in the work. The binding energy B is reproduced for a cutoff value corresponding to $\delta M \sim 1.7$ MeV, this being the δM calculated by Pagels. Both electromagnetic effects and the deuteron breakup into an S-wave, triplet-state nucleon pair are considered for contributions to B. No realistic estimate was made of the effect on the result of π mesons in the intermediate-state expansion. The two-nucleon-state contribution dominates the results, accounting for approximately 90% of B at the experimental value of 2.2 MeV. (auth)

59527 TWO-QUANTUM RADIATIONAL CAPTURE OF A SLOW NEUTRON BY A PROTON. Grechukhin, D. P. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 14: No. 1, 109-19 (Jul 1971). (In Russian).

Two-quantum capture of a slow neutron by a proton with transition from the triplet S state of the np system to the bound (deuteron) state is considered. The cross section of the process is more than the cross section for capture with emission of one M1 or E2 quantum and is comparable with the cross section for production of the electron–positron pair at the E0 transition of the system. Angular and spectral distributions of the emitted quanta are obtained. At the neutron energy $E_0 = 0.025$ eV the two-quantum capture cross section is $\sigma_{\gamma\gamma}^{1\to 1} \simeq 1.2 \cdot 10^{-32}$ cm^2, that is near the limit accessible to the present experimental technique. Application of the obtained estimate of the two-quantum capture cross sections to the reactions $^2H_1 + n \to {}^3H_1 + \gamma_1 + \gamma_2$ and $^3He_2 + n \to {}^4He_2 + \gamma_1 + \gamma_2$ results in the quantities of about 10^{-31} and 10^{-30} cm^2, while the one-quantum capture cross sections in these cases are $5 \cdot 10^{-28}$ and 10^{-28} cm^2, respectively. Thus, in the neutron capture reactions on nuclei $^2H_1$ and $^3He_2$ the background ratio of the two-quantum process to the one-quantum capture is essentially better than in usual nuclear transitions where it is of the order of magnitude of 10^{-6}–10^{-5}. (auth)

59528 METHOD TO CALCULATE AMPLITUDES FOR SCATTERING OF FAST PARTICLES ON NUCLEI. **Gurvits, S. A.; Marinov, M. S. Yadern. Fiz.; 14: No. 1, 120-30(Jul 1971). (In Russian).**

A method to calculate amplitudes for interaction of particles with nuclei based on the relativistic Feynman graphs in momentum representation is considered. The relation to the Glauber approach is shown. Techniques of the calculations with account of the particle spins are presented. The case of the three–nucleon target nucleus is investigated in detail. (auth)

Particle Invariance Principles and Symmetries

Refer also to abstract 59430.

59529 DOUBLE-PEAKED LOG TAN½ θ DISTRIBUTIONS AND THEIR RELATION TO FIREBALLS. Zgrablich, G. (Univ. Nacional de Cuyo, San Luis, Argentina). Phys. Rev., D; 4: No. 3, 871-4(1 Aug 1971).

The double-peaked feature of the log tan½ θ distribution of secondary particles in a cosmic-ray jet is predicted not only by the two-fireball model, but also by a number of other phenomenological and empirical models. It is shown that in these models there is also a simple explanation for the occurrence of the two peaks, namely, the independence of $p_{||}$ from p_t in the c.m. system. Infi-

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nite-fireball models do not lead to the double-peaked distribution even when two groups (or clouds) of fireballs are considered. (auth)

General

59530 GROUP THEORY AND THEORETICAL PHYSICS. Lipkin, H. J. (Weizmann Inst. of Science, Rehovoth, Israel. Argonne National Lab., Ill.). pp 381-99 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

59531 GROUP DEFORMATIONS AND RELATIVITY. Rogozhin, Yu. A. (Inst. of Physics and Energetics, Obninsk, USSR). Int. J. Theor. Phys.; 4: No. 5, 361-88(Sep 1971).

A theory of deformation (homeomorphism but non-isomorphism) of topological groups is developed. In particular, a theory of deformation of subgroups structure is considered. The whole formalism is based on conceptions of holonomicity and relative geometry. A field is postulated to deform the symmetry group of a free physical system. It is shown that the classical fields deform the Poincare group. Thanks to this fact, gravitation appears as space-time curvature (non-holonomicity of the Lorentz subgroup mapping); and electromagnetism reveals itself by space–time torsion (non-holonomicity of the translation subgroup mapping). From physically evident premises it follows that space–time also has a torsion in the rotating and accelerated systems of reference. (auth)

59532 REMARKS ON LIGHTLIKE CONTINUOUS SPIN AND SPACELIKE REPRESENTATIONS OF THE POINCARE GROUP. Chakrabarti, A. (Ecole Polytechnique, Paris). J. Math. Phys. (N. Y.); 12: No. 9, 1813-22(Sep 1971).

Certain classes of unitary representations of the lightlike continuous spin and the spacelike cases are constructed. The generators in these representations involve operators forming the "intrinsic" algebras (i.e., commuting with the orbital parts) E_3 and O(3,1) for $P^2 = 0$ and $P^2 < 0$, respectively. The parallel construction for $P^2 > 0$ involving an intrinsic O_4 algebra is indicated. Equivalence relations with certain other forms are given through a unitary transformation. The physical significance of the "translation" generators of E_3 is brought out in terms of the projections of W orthogonal to P. Corresponding results for the $O_{(3,1)}$ and $O_{(4)}$ algebras are given. For the continuous-spin case, these operators are shown to provide a basis with extremely simple transformation properties, related to a certain symmetric toplike behavior even under Lorentz transformations. With a view to future use, the matrix elements of W on the energy-rotation basis are calculated in a unified manner for all the three cases, $P^2 \lesseqgtr 0$. A deformation formula leading from zero-mass continuous-spin representations to spacelike ones is studied. Certain types of nonunitary representations are briefly introduced at the end. (auth)

59533 LORENTZ BASIS OF THE POINCARE GROUP. II. Chakrabarti, A. (Ecole Polytechnique, Paris). J. Math. Phys. (N. Y.); 12: No. 9, 1822-40(Sep 1971).

The transformation coefficients connecting the momentum and Lorentz bases of the unitary representations of the Poincaré group are derived for timelike, lightlike, and spacelike momenta ($P^2 \gtreqless 0$) and for arbitrary spin (i.e., for general values of W^2) in each case. (auth)

59534 BOSON CALCULUS FOR THE ORTHOGONAL AND SYMPLECTIC GROUPS. Lohe, M. A.; Hurst, C. A. (Univ. of Adelaide). J. Math. Phys. (N. Y.); 12: No. 9, 1882-9(Sep 1971).

The boson calculus as used for U(n) cannot be applied directly to O(n) and Sp(n). Modifications are made to boson operators, in order to obtain new operators which enable explicit states of irreducible representations of O(n) and Sp(n) to be constructed. Calculations for O(3) and O(4) show how these operators permit a greater simplicity, and reveal more fully the group structure than has previously been the case. (auth)

59535 DECOMPOSITION SO(p,1) ⊃ SO(p − 1,1) FOR MOST DEGENERATE REPRESENTATIONS. Boyer, Charles P.; Ardalan, Farhad (Pennsylvania State Univ., University Park, Pa.). J. Math. Phys. (N. Y.); 12: No. 10, 2070-5(Oct 1971).

The problem of decomposing the matrix elements for degenerate representations of SO(p,1) according to the noncompact subgroup SO(p − 1,1) is discussed. The overlap functions which obtain this decomposition are calculated explicitly and their properties are used to discuss the SO(p,1) generalized Regge expansion. (auth)

59536 REPRESENTATIONS OF O(3). Tripathy, Kishor C. (Inst. of Theoretical Physics, Goteborg). J. Math. Phys. (N. Y.); 12: No. 10, 2136-43(Oct 1971).

The various classes of local irreducible representations (both finite- and infinite-dimensional) of O(3) realized on a linear complex vector space are analyzed. The well-known finite-dimensional unitary representations are obtained when the scalar product is positive definite. The infinite-dimensional representations are realized on an indefinite metric space. The possible applications of these new classes of representations are briefly discussed. (auth)

59537 CHARACTERISTIC IDENTITIES FOR GENERATORS OF GL(n), O(n) AND Sp(n). Green, H. S. (Univ. of Adelaide). J. Math. Phys. (N. Y.); 12: No. 10, 2106-13(Oct 1971).

A hierarchy of tensor identities, satisfied by the generators of the general linear group GL(n), is obtained in terms of two different sets of invariants. An application to the identification of irreducible representations and the decomposition of reducible representations is described. Similar results are obtained for the generators of orthogonal, pseudo-orthogonal, and symplectic groups. (auth)

59538 VECTOR OPERATORS AND A POLYNOMIAL IDENTITY FOR SO(n). Bracken, A. J.; Green, H. S. (Univ. of Adelaide). J. Math. Phys. (N. Y.); 12: No. 10, 2099-2106(Oct 1971).

It is shown that if α denotes an n × n antisymmetric matrix of operators α_{pq}, p, q = 1, 2, . . . , n, which satisfy the commutation relations characteristic of the Lie algebra of SO(n), then α satisfies an nth degree polynomial identity. A method is presented for determining the form of this polynomial for any value of n. An indication is given of the simple significance of this identity with regard to the problem of resolving an arbitrary n-vector operator into n components, each of which is a vector shift operator for the invariants of the SO(n) Lie algebra. (auth)

Applications (Electromagnetic and Weak)

59539 POSSIBLE MECHANISM FOR CP NONCONSERVATION. Biedenharn, L. C. (Duke Univ., Durham, N. C.); Han, M. Y.; van Dam, H. Lett. Nuovo Cim.; 2: No. 14, 730-3(2 Oct 1971).

It was recently shown that the iterated Dirac equations allows two qualitatively distinct factorizations into first-order equations. The discrete symmetry properties of the stigma operator appearing in one of the equations are discussed, and a possible mechanism for CP nonconservation is obtained. (L.B.S.)

59540 CP-INVARIANCE VIOLATION AS A SECOND-ORDER WEAK EFFECT. Lane, Kenneth; Chodos, Alan (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett.; 27: No. 14, 966-9 (4 Oct 1971).

In an attempt to make second-order weak interactions finite, the usual current-times-current theory was modified by the introduction of nonpolynomial functions $\exp[f\varphi^\dagger\varphi]$ of a scalar field φ. Choosing the various minor coupling constants f to be complex leads naturally to the appearance of CP-invariance violation in $O(G^2)$. The model is used to study the $K^0-\bar{K}^0$ system and find $\eta_{+-} \cong \eta_{00}$, which is consistent with recent preliminary experimental results. (auth)

59541 BREAKING NAMBU–GOLDSTONE CHIRAL SYMMETRIES. Li, Ling-fong; Pagels, Heinz (Rockefeller Univ., New York). Contract AT(30-1)-4204. Phys. Rev. Lett.; 27: No. 16, 1089-92(18 Oct 1971).

It is established that the nonanalytic behavior of some matrix elements in perturbation theory about a chiral symmetry implies that they can be calculated exactly to leading order in chiral breaking. For other matrix elements, analytic to leading order, the hypothesis of threshold dominance in the chiral limit is established. As an application of this idea one calculates to leading order in chiral breaking, the seven baryon–octet mass differences in terms of one parameter. .(auth)

59542 ASPECTS OF CONFORMAL SYMMETRY AND CHIRALITY. Ellis, John (Cambridge Univ., Eng.). Nucl. Phys.; B22: No. 2, 478-92(1970).

Two simple Lagrangian models combining conformal symmetry and current algebra are exhibited. Either both symmetries are realized linearly, or both symmetries are realized in the Goldstone manner. The scalar isoscaler to pseudoscalar meson couplings differ from those obtained by naive low-energy theorems: $g_{\sigma\pi\pi}/g_{\sigma N\bar{N}} \approx m_\sigma^2/2m_N$. It is argued that a Lagrangian term violating conformal symmetry but invariant under SU(2) × SU(2) is necessary. If one identifies conformal and SU(3) × SU(3) breaking Lagrangian terms, acceptable relations between masses and coupling constants are obtained. The prediction of the Goldstone type realization of conformal symmetry for scalar meson production in the process $e^-e^+ \rightarrow (\phi) \rightarrow \pi^-\pi^+\gamma$ is discussed. (auth)

59543 T INVARIANCE AND THE UNITARITY LIMIT IN $K_L^0 \rightarrow \mu^+\mu^-$. Chen, H. H. (Univ. of California, Irvine); Lee, S. Y. Phys. Rev., D; 4: No. 3, 903-5(1 Aug 1971).

The role of T invariance in the unitarity (lower) limit of the decay $K_L^0 \rightarrow \mu^+\mu^-$ is examined. It is noted that the assumption of T invariance is necessary only insofar as ϵ, the CP-violating parameter in the neutral K system, is nonzero. Because of the smallness of this parameter, a chance cancellation appears unlikely. Therefore, the unitarity (lower) limit for $K_L^0 \rightarrow \mu^+\mu^-$ can be decreased only (with the above exception) by including in the unitarity sum intermediate states other than the two-photon state (e.g., three-pion states). (auth)

59544 NEUTRAL KAON DECAYS INTO MUON PAIRS AND THE VIOLATION OF CP INVARIANCE. Martin, B. R. (University Coll., London); de Rafael, E.; Smith, J.; Uy, Z. E. S. Phys. Rev., D; 4: No. 3, 913-15(1 Aug 1971).

Some implications of nonconservation of CP invariance for $K_L \rightarrow \mu^+\mu^-$ are discussed with reference to a recent experimental result on this decay. (auth)

59545 ASYMMETRY IN THE ASYMPTOTIC IDENTIFICATION. Uzes, C. A. (Univ. of Georgia, Athens). Nuovo Cim.; 5A: No. 3, 345-56(1 Oct 1971).

The compatibility of the notion of an internal symmetry group with the asymptotic identification for an electromagnetic part of the non-Abelian gauge field is investigated on the classical level. It is shown that the asymptotic identification would restrict, without the necessity of violating local gauge invariance, internal symmetry transformations to those which commute with the generator of electromagnetic gauge transformations. Local gauge transformations would be restricted in the same way in the region of definability of the gauge field's electromagnetic part. Based upon these restrictions, a model for the structure of the gauge field's sources and interactions is conjectured in order to illustrate how the known SU_2 and SU_3 dynamical symmetry and internal particle labeling schemes might arise from a local gauge theory employing an asymptotic identification. (auth)

Applications (Strong)

59546 CLASSIFICATION AND MASS FORMULAS FOR MESONS IN THE LADDER U(6,6) SYMMETRY. Drenska, S.; Ivanov, M.; Nikolov, A.; Vaklev, J. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 24: No. 4, 443-5(1971).

A previous idea of classifying hadrons by means of ladder U(6,6) series is modified and generalized. The meson ladder B = 0 is considered. The rung (6,6*) is identified with the meson 36-plet, which reduces to two Schwinger nonets called fundamental states. The rest of the meson states are obtained from a given rule. The isotopical multiplets of rungs (6,6*) and (21,21*) are arranged in a table. The table also included the masses of the predicted particles calculated from the mass formulas obtained. (J.F.P.)

59547 THEORY OF GRAVITY IN THE FRAMEWORK OF THE LORENTZ COVARIANT AND SECOND QUANTIZED FORMALISM. Sato, Shigeo (Rikkyo Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 46: No. 1, 282-96(Jul 1971).

On the basis of the remark that the gravitational interaction really acts with the binding energy, the emphasis is laid on the necessity of treating the gravitational interaction by the method of particle physics irrespective of the general relativity. Accordingly, the interaction of a massless particle with spin 2 (graviton) is investigated by using the method which has been applied to the reformulation of quantum electrodynamics by the present author. As a result, the theory of gravitational interaction can be formulated in an unambiguous manner, in which the interaction of gravitational field with the binding potential is successfully derived. The rotation of the perihelion is calculated by taking into account higher order corrections to the gravitational interaction, and a value which is about 8% smaller than the result of general relativity is obtained. This is exactly the value expected by Dicke and Goldenberg from their measurement of the solar oblateness. As regards the behavior of the photon in the gravitational field, the theory reveals some features different from general relativity. This difference, which concerns the universality of the coupling constant in our theory, will be tested by more precise experiments about the gravitational deflection of light or by experiments about the change of light velocity in the gravitational field. (auth)

59548 BARYON MASS AND ELECTROMAGNETIC INTERACTIONS IN O(4,2) x SU(3). Monsma, William Brink. Boulder, Colo.; Univ. of Colorado (1971). 122p. University Microfilms Order No. 71-21,610.
Thesis.

Earlier work describing baryons by the group O(4,2) is extended to include the SU(3) classification scheme. The simplest possible group is used, O(4,2) × SU(3). The representations used are formed from a particular representation of O(4,2) and from the octet and decuplet representations of SU(3). It is found that these two structures are contained in a single irreducible representation of O(4,2) × SU(3) × SU(3). This representation space includes all observed baryon states, with the possible exception of some SU(3)-singlet states. The postulates of the theory include an infinite-component wave equation, a conserved probability current, and a conserved electric current. From these are derived formulas for the mass and the electromagnetic form factors. Finally, from this mass formula, the Okubo mass formula is derived. (Diss. Abstr.)

59549 DUALITY AND REPRESENTATION MIXING IN THE NON-CHIRAL U(6) × U(6). Horwitz, L. P. (Univ. of Denver). Nucl. Phys.; B34: No. 1, 136-56(1971).

Using a classification of baryons and mesons in mixed representations of the non-chiral U(6) × U(6), it is shown that a simple construction analogous to duality diagrams reproduces all of the predictions of the duality diagrams for MM, MB and BB reactions (with some additional weakly allowed inelastic MB processes), but provides predictions for the energy dependence of $B\bar{B}$ amplitudes as well. The U(6) × U(6) formulation provides a natural interpretation for the application of "annihilation" criteria, accounting, for example, for stronger energy dependence in π^-p than in π^+p total cross sections, and predicting stronger energy dependence in $p\bar{\Xi}^+(10 + 27)$ than in $p\Xi^+(27)$. Results are also given for multiparticle processes. (auth)

59550 SIGMA COMMUTATOR AND FEATURES OF (8,8) SYMMETRY BREAKING. Brehm, J. J. (Univ. of Massachusetts, Amherst). Nucl. Phys.; B34: No. 1, 269-91(1971).

The Gell-Mann–Oakes–Renner model of SU(3) × SU(3) breaking provides a pion sigma commutator σ^{jk} which has no isospin T = 2 component. Because of this and especially in view of recent evidence that this model is not experimentally confirmed in meson–baryon scattering, another model employing (8,8) breaking is considered. A hamiltonian of the Barnes–Isham form is adopted and the operators are developed for use in an analysis of the pion-to-pion matrix element of σ^{jk}. Estimates are made of the parameters of this model, and the T = 0 and 2 form factors of the matrix element are examined by means of a hard pion formalism adapted to analytic function methods. The T = 0 and 2 s-wave $\pi\pi$ phase shifts are extracted. It is shown that the (8,8) model, analyzed in this way, provides an unsatisfactory description of the existing data on these phase shifts. The data identify the reason for this failure to be that the T = 2 component of σ^{jk} is too large in the (8,8) model. The outlook for other alternatives is discussed. (auth)

59551 REALIZATION OF CHIRAL SYMMETRY IN THE MESON STATES THROUGH SU(4) ⊗ O(3). Boldrighini, C.; Buccella, F.; Celeghini, E.; Sorace, E.; Triolo, L. (CERN, Geneva). Nucl. Phys.; B22: No. 2, 651-7(1970).

A saturation scheme is proposed for the equations $[X_a(h), X_b(h)] = i\epsilon_{abc}T_c$, $[X_a(h), [X_b(h), m^2]] = \frac{1}{3}\delta_{ab}[X_c(h), [X_c(h), m^2]]$, within the lower meson states, which belong to the 15 L = 0, 1 representations of SU(4) ⊗ O(3). With the introduction of two mixing parameters the chiral couplings of these particles are derived in reasonable agreement with experiment. In particular the helicity properties of A_1 and B decays come out correctly. (auth)

59552 PROPOSED METHOD FOR A SEARCH FOR C VIOLATION VIA ρ^0 INTERFERENCE IN ω DECAY. Abrams, G. S.; Goldhaber, G.; Hall, B. H. (Univ. of California, Berkeley). Phys. Rev., D; 4: No. 3, 647-52(1 Aug 1971).

A method is suggested to search for the existence of a C-violating transition in ρ^0 decay. The method requires a simultaneous analysis of both the usual ρ^0 decay channel $\pi^+\pi^-$, and the G-violating channel $\pi^+\pi^-\pi^0$. The $\pi^+\pi^-$ mass distribution is used to determine the kinematic regions of coherence of the ρ^0 and ω production amplitudes and the relative $\rho-\omega$ production phase. It is shown that one may then use the $\omega \rightarrow \pi^+\pi^-\pi^0$ Dalitz plot as an analyzer of the isospin of the 3π final state from ρ^0 decay via a generalized asymmetry analysis of the ω Dalitz plot for data samples in which $\rho-\omega$ coherence is observed. A general discussion of the effects of the $\rho \rightarrow 3\pi$ decay mode upon the ω is presented, with emphasis on the search for the isospin-conserving, C-violating decay mode. The relation of the $\rho-\omega$ interference method to other methods to search for C violation is also discussed. (auth)

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Field Theories

General

Refer also to abstract 59547.

59553 SPINOR HYPERPLANE FIELD THEORY. **Ardalan, Farhad.** University Park, Pa.; Pennsylvania State Univ. (1970). 90p. University Microfilms Order No. 71-21,717.
Thesis.

A field theory capable of describing an infinite number of half integer spin particles is developed, by extending the domain of definition of the fields from the Minkowski space, R^4, to a homogeneous space of the Poincaré group, $R^4 \times H^3$; where H^3 consists of the set of time-like unit 4-vectors normal to the space-like hyperplanes associated with the position measurements. The differential equation for the fields has an infinite number of nonparallel linear trajectories for its time-like mass spectrum. The space-like and light-like solutions are avoided as a consequence of the requirement of existence of the conserved quantities of the theory. A variational principle is used and a local conserved current is constructed, leading to the form factors for the lowest-lying state, which agree qualitatively with the proton form factors. Micro-causality is satisfied provided the solutions of the field equation form a complete set. The completeness problem is briefly considered. (Diss. Abstr.)

59554 SUPERHEAVY ELEMENTS AND AN UPPER LIMIT TO THE ELECTRIC FIELD STRENGTH. **Rafelski, Johann; Fulcher, Lewis P.; Greiner, Walter** (Univ., Frankfurt am Main). Phys. Rev. Lett.; 27: No. 14, 958-61(4 Oct 1971).

An upper limit to the electric field strength, such as that of the nonlinear electrodynamics of Born and Infeld [Proc. Roy. Soc., Ser. A, 144: 425(1934)], leads to dramatic differences in the energy eigenvalues and wave functions of atomic electrons bound to superheavy nuclei. For example, the $1s_{1/2}$ energy level joins the lower continuum at Z = 215 instead of Z = 174, the value obtained when Maxwell's equations are used to determine the electric field. (auth)

59555 MASSIVE VECTOR MESONS WITH GAUGE-INVARIANT LAGRANGIAN. **Heskia, S.** (London Univ.). Nuovo Cim.; 5A: No. 2, 305-14(21 Sep 1971).

It is shown that the compensating quantity, or the connection Γ^{A}_{Br}, which parallel translates simultaneously the field and antifield $\psi_A = \psi_\alpha / \psi^*_\alpha$ to the neighboring event has the desired feature of having a tensor $\Gamma^{\alpha}_{\beta \cdot r}$ as its subconnection, so that the latter's linear transformation law makes it possible to construct a gauge-invariant mass term for the gauge field $A^{(a)}_r$ that stems from $\Gamma^{\alpha}_{\beta \cdot r} = igA^{(a)}_r T^{\alpha}_{(a)\beta \cdot}$. It is further postulated that the expansion coefficient of the subconnection $\Gamma^{\alpha}_{\beta r}$ stands for the electromagnetic component of the non-Abelian gauge field. (auth)

Quantum Field Theory

Refer also to abstracts 59232, 59345, and 59622.

59556 (IPP-6/95) TACHYON MECHANICS AND CLASSICAL TUNNEL EFFECT. **Wimmel, H. K.** (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). May 1971. 43p. Dep. NTIS (U. S. Sales Only).

A model mechanics is established for classical, charged, point tachyons, with omission of Cerenkov radiation. The principle of relativity provides that several observables, e.g. electric charge, momentum, and energy of tachyons, do not show the usual Lorentz covariance, but transform as "metascalars", "metavectors", etc.; Lorentz covariant quantities are associable with them, but the signs of some of these are not observable. A critical survey of tachyon kinematics and of "supraluminal reference frames" is given. In tachyon dynamics it follows from the principle of relativity that the sign of the observable kinetic energy is Lorentz invariant, while the sign of the observable electric charge is not. Any reinterpretation of negative energies is neither required nor possible. Classical tachyons may undergo pseudocreation and pseudoannihilation, which differ from ordinary creation and annihilation in that their world points depend on the frame of reference. Closed world lines may occur. Tachyons show a classical tunnel effect, which is discussed in detail. Classical tachyon mechanics may be useful for developing a Maxwell-Vlasov theory of tachyon plasmas. (auth)

59557 NEW METHOD OF QUANTIZATION FOR VARIOUS FIELDS. I. GENERAL FORMULATION. **Yamada, Mitsuru** (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 1, 256-81(Jul 1971).

A method of quantization which is applicable to finite and infinite component fields with arbitrary mass spectra, is proposed. It is based on analyticity of the propagators, and has no recourse to the canonical formalism. Causality and the relativistic covariance are manifest from the outset. It appears that, according to this method, a local field theory is possible by starting not with Lagrangians but with analytic propagators. Various properties related to complex poles of the propagators are briefly discussed. (auth)

59558 CONSISTENCY BETWEEN LAGRANGE AND HAMILTONIAN FORMALISMS IN QUANTUM MECHANICS. CASE OF NON-RELATIVISTIC VELOCITY-DEPENDENT POTENTIAL. **Sugano, Reiji** (Osaka City Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 1, 297-307(Jul 1971).

Consistency between the Lagrangian and the Hamiltonian formalisms in the quantum mechanics is investigated for the type of Lagrangian $L = \frac{1}{2}\dot{q}_i g_{ij}(q)\dot{q}_j - v(q)$ as an extension of a previous paper. The variations δq_i and $\delta \dot{q}_i$ should be considered as q-numbers. When the Lagrangian can be transformed into the standard form $L = \frac{1}{2}\dot{Q}^2_\alpha - V(Q)$, the commutation relations of δq_i and $\delta \dot{q}_i$ with q_j and $\dot{q}_j$ are found with the help of Q-coordinate system. It is shown that using the commutation relations, the variation principle leads to the same equation of motion as the canonical equation of motion which is obtained in the previous paper. (auth)

59559 GENERALIZATION OF QUANTUM FIELD THEORY ON THE BASIS OF FUNCTION MANIFOLD. **Azuma, Shuko** (Fukusima Univ., Japan). Progr. Theor. Phys. (Kyoto); 46: No. 1, 308-31(Jul 1971).

A function manifold can be regarded as a unity of space-time and matter. Based on this circumstance an attempt is made to generalize the local quantum field theory to quantum field theory on a function manifold. A Lagrangian theory for the interacting Dirac and vector gauge fields is studied as a definite model theory. A c-number field on the manifold is equivalent to a composite of certain basic quanta, so that these composite systems can be dealt with in place of space-time functions in the local theory. It is shown that the interaction has a non-local feature. Furthermore, in place of an algebraic self-consistent mass equation for elementary particles of a local field theory, a self-consistent integral mass eigenvalue equation is obtained for the composite fields representing an elementary particle. Owing to these properties it is shown that perhaps the difficulty of the ultraviolet divergence will principally be overcome. (auth)

59560 HIGH-FIELD ELECTRON g -2 MEASUREMENT. **Wesley, John C.; Rich, Arthur** (Univ. of Michigan, Ann Arbor). Phys. Rev., A; 4: No. 4, 1341-63(Oct 1971).

The g-factor anomaly of the free electron was measured to an accuracy of ±3 ppM (68% confidence level). The method (a refinement of that used by Wilkinson and Crane in 1963) is based on a direct observation of the difference between the spin precession and cyclotron frequencies of 100-keV electrons confined in a precisely measured magnetic mirror trap. An order of magnitude increase in precision over the Wilkinson-Crane experiment was achieved by (a) a tenfold increase in the magnitude of the magnetic field (to 1 kG), and (b) a tenfold reduction in the relative depth of the magnetic trap (to 60 ppM). An extensive series of tests for systematic effects at the 1-ppM level was also carried out. With $a = \frac{1}{2}(g-2)$, we find $a_{expt}(e^-) = (1{,}159{,}657.7 \pm 3.5) \times 10^{-9}$. The difference between this result and the current theoretical expression for a, as calculated through second order in the fine-structure constant α, is $a_{expt}(e^-) - [0.5(\alpha/\pi) - 0.32848(\alpha/\pi^2] = (1.68 \pm 0.33)(\alpha/\pi)^3$. In the above, $\alpha^{-1} = 137.03608 \pm 0.00026$ was used, as recently recommended by Taylor, Parker, and Langenberg. The uncertainty in the coefficient is the rms sum of our experimental error and the uncertainty in α^{-1}. In this form, the result can be interpreted as an experimental determination of the sixth-order quantum-electrodynamic contribution to the anomaly. Current estimates of this quantity are $1.49(\alpha/\pi)^3$. (auth)

59561 PARASTATISTICS WITH VARIABLE NUMBERS OF PARTICLES. **Stolt, R. H.; Taylor, J. R.** (Univ. of Colorado, Boulder). Nuovo Cim.; 5A: No. 2, 185-96(21 Sep 1971).

The properties of two possible first-quantized theories for a variable number of identical paraparticles are examined. In one (the "ray" theory), states are described by vectors in a Fock space constructed as the direct sum of the fixed-particle "ray" Hilbert spaces; in the other (the "generalized-ray" theory), the Fock space is constructed from the "generalized ray" Hilbert spaces. The "ray" theory, which is equivalent to the second-quantized parafield theory, appears to be consistent with all reasonable physical requirements. However, it is shown that the "generalized-ray" theory cannot consistently describe systems in which the particle numbers can vary. This is achieved by showing that an absolute selection rule derived previously in the "generalized ray" framework prohibits the creation and destruction of particles. (auth)

59562 CONTINUOUS MEDIUM DEFORMATION FIELD IN MINKOWSKI SPACE-TIME. **Maugin, G. (Princeton Univ., N. J.). Compt. Rend., Ser. A; 273: No. 1, 65-8(5 Jul 1971). (In French).**

Some properties of continuous medium deformations in a Minkowski space-time are stated. (France)

59563 WAVE MECHANICAL INTERPRETATION OF FREE QUANTIZED FIELDS WITH THE HELP OF CLIFFORD ALGEBRAS AND AN OUTLINE FOR A WAVE MECHANICAL THEORY OF INTERACTIONS. **Sutter, Erich Erwin. Riverside, Calif.; Univ. of California (1970). 213p. University Microfilms Order No. 71-20,262.**

Thesis.

The formalism for the theory of free quantized fields is reinterpreted with the help of Clifford algebras. The creation and annihilation operators are considered as elementary c-number fields that satisfy the free field equations. Their commutator is identified with the scalar product of these fields which is defined by the expression for the classical charge. The commutation relations then represent the equivalence relations which can be postulated in the tensor algebra over the space of free fields in order to define the Clifford algebra. The interpretation of the field theoretical commutation relations as equivalence relations in a tensor algebra has two important consequences: The operator formalism of quantized free fields appears to be just a method for the calculation of wave mechanical quantities. Concepts like the creation and annihilation operators and the vacuum state are only auxiliary devices for these calculations and can be eliminated. The symmetry of the Clifford algebra equivalence relations is determined by the symmetry of the charge expression with respect to the exchange of the field with its complex conjugate. It follows that the fields with a symmetric charge expression lead to Fermi statistics whereas antisymmetric charge expressions are related to Bose statistics. The Clifford algebra formalism thus not only allows one to describe both types of statistics, but also relates them to the symmetry of a wave mechanical quantity. In this way a close relation is established between the theory of the free quantized scalar, spinor, vector and electromagnetic fields and a wave mechanical theory. The properties of the various free wave functions are studied from the representation theoretical point of view. The knowledge of this wave mechanical groundwork and its relation to quantum field theory makes it possible to propose a wave mechanical approach to interactions which is completely finite. A Lagrangian theory of this type is outlined for the case of quantum electrodynamics. It is clear, however, that the approach is not restricted to this area and might be of particular interest, e.g., in the handling of interactions which lead to nonrenormalizable quantum field theories. The new approach to quantum electrodynamics leads to coupled integral equations. With help of the proper boundary conditions these equations can be solved by iteration. If the terms of the iterative expansion are represented by diagrams with the help of the usual Feynman rules, one obtains graphs which differ from Feynman graphs in two ways: they cannot contain any closed loops and the same external line can occur more than once. To the lowest nonvanishing order the matrix elements for Compton and Coulomb scattering are the same as in quantum field theory. A preliminary investigation shows that besides the absence of divergent diagrams in the wave mechanical approach the two theories will most likely also be in good agreement when contributions up to the fourth order in the coupling constant are considered. (Diss. Abstr.)

59564 RENORMALIZED FIELD PRODUCT, BJORKEN LIMIT, WARD IDENTITY, AND THE STATIC MODEL. **Bui-Duy, Q. (Univ. of Montreal). Nuovo Cim.; 5A: No. 2, 224-38 (21 Sep 1971).**

The point-source static model is used to study renormalized field products at small distances. The field has an anomalous dimension which varies with the coupling constant. The singularity of the field product at short distances is traced to the Haag phenomenon and the infinite self-mass. The exact Bjorken limit is calculated, and the subtracted Ward identity is examined. If either the effective equal-time commutator or the analytic continuation in the coupling constant is postulated, the subtractions are unambiguously determined. (auth)

59565 BOUNDS ON THE ELASTIC AMPLITUDE IN NON-LOCALIZABLE FIELD THEORIES. **Fainberg, V. Ya. (Max-Planck-Institut fuer Physik und Astrophysik, Munich); Iofa, M. Z. Nuovo Cim.; 5A: No. 2, 275-96(21 Sep 1971).**

The relation is established between the properties of the elastic amplitude F(S,Z) at high energies and the properties of the vacuum expectation values (VEV) in a class of essentially nonlocalizable field theories in which the growth of VEV's in the momentum space is bounded by $\exp [B\|p\|^{2\alpha}]$, $\alpha > 1/2$, and in which it is possible to prove the cluster decomposition properties for the truncated Wightman functions. The following bounds are established on the partial-wave amplitudes: $|\overline{f_1(S)}| < C' \exp [AS^{\alpha} - C_1(l/S)]$. These bounds lead to the Greenberg-Low-type bounds on the elastic amplitude: $|\bar{F}(S, \cos\theta)| < CS^{2+2\alpha}$, and to the analyticity of the amplitude $\bar{F}(S,Z)$ in the Lehmann-type ellipse. The bounds on the partial-wave amplitudes are derived by making use of the cluster properties of the truncated Wightmann functions which reflect the short-range nature of the force between the particles. (auth)

59566 EQUAL-TIME CHARGE-CURRENT COMMUTATOR IN QUANTUM ELECTRODYNAMICS. **Pradhan, T. (Saha Inst. of Nuclear Physics, Calcutta). Lett. Nuovo Cim.; 2: No. 14, 724-6(2 Oct 1971).**

It is shown that the coefficient of the derivative delta-function in the one-electron expectation value of the equal-time charge-current commutator is different from the corresponding coefficient in the vacuum expectation value of this commutator which is known to be a quadratically divergent quantity. It is concluded that the equal-time charge-current commutator is a q-number if it is proportional to derivative of a delta-function. (L.B.S.)

59567 INEQUIVALENCE OF REPRESENTATIONS OF COMMUTATION RELATIONS OBTAINED BY ORTHOGONAL TRANSFORMATIONS IN FIELD THEORY. **Bose, S. K.; Henneberger, W. C. (Southern Illinois Univ., Carbondale). J. Phys., A (London); 4: No. 5, 646-8(Sep 1971).**

It is shown that, except under very special conditions, orthogonal transformations on the field coordinates of a Bose-Einstein field cannot be represented as transformations in the Hilbert space of the boson field. The proof is restricted to rotations which are products of commuting rotations in two-dimensional subspaces. (auth)

59568 REGULARIZATION OF THREE-VERTEX FEYNMAN DIAGRAMS PRODUCED BY THREE-POINT SUPERGRAPHS. **Fanchiotti, H.; Garcia Canal, C. A.; Girotti, H.; Vucetich, H. (Universidad Nacional, La Plata). Nucl. Phys.; B34: No. 1, 307-16(1971).**

The infinity suppression mechanism of the ultraviolet divergences of quantum field theory provided by a non-polynomial interaction Lagrangian is analyzed in connection with some non-hadronic reactions and compared with the usual method of analytic regularization. The action of the three-point supergraph is studied in this context. It is shown that, as a consequence of the action of "gravity," the propagators become regularized and an average over the regularization parameter replaces the limiting process characteristic of the analytic regularization method. It is found that the resulting "gravity"-modified amplitudes associated with three-vertex Feynman diagrams can be decomposed as a sum of terms of different order in the minor coupling constant. Possible detectable changes induced by the presence of massless "gravitons" on some relevant leptonic processes are also investigated. (auth)

59569 EIKONAL FORMULATION IN NEUTRAL SCALAR FIELD THEORY. **Dittrich, Walter (Univ., Tuebingen, Ger.). Nucl. Phys.; B34: No. 1, 227-36(1971).**

A detailed study is presented of the eikonal approximation in a field theory with interaction Lagrangian $L' = -\frac{1}{2}g\psi^2\phi$. Eikonal propagators are obtained in a prescribed external field and used to evaluate a certain subclass of Feynman diagrams. Contrary to QED it is not possible to generate a bound state spectrum by an infinite mass limit. The problem is approached using Schwinger's functional methods. (auth)

59570 FIELD THEORY OF SPIN-TWO MESONS AND AN EQUIVALENCE THEOREM. **Horvath, Z. (Roland Eoetvoes Univ., Budapest). Nucl. Phys.; B33: No. 1, 214-20(1971).**

The LSZ formulation of the theory of spin-two particles is discussed. The influence of the properties of the tensor current on the superfluous components of the interpolating field is studied. By means of the asymptotic condition it is shown that one can always construct a spin-two tensor field which satisfies all the subsidiary conditions without changing the S-matrix and the four-momentum operator. (auth)

59571 RENORMALIZATION OF MASSLESS YANG-MILLS FIELDS. **Hooft, G.'t (Univ. of Utrecht). Nucl. Phys.; B33: No. 1, 173-99(1971).**

The problem of renormalization of gauge fields is studied. It is observed that the use of non-gauge invariant regulator fields

XUM

is not excluded provided that in the limit of high regulator mass gauge invariance can be restored by means of a finite number of counter-terms in the Lagrangian. Massless Yang–Mills fields can be treated in this manner, and appear to be renormalizable in the usual sense. Consistency of the method is proved for diagrams with non-overlapping divergencies by means of gauge invariant regulators, which however, cannot be interpreted in terms of regulator fields. Assuming consistency the S-matrix is shown to be unitary in any order of the coupling constant. A restriction must be made: no local, parity-changing transformations must be contained in the underlying gauge group. The interactions must conserve parity. (auth)

59572 INTERPRETATION OF ANOMALIES IN WARD IDENTITIES. Kummer, W.; Schweda, M. (Oesterreichische Akademie der Wissenschaften, Vienna. Technische Hochschule, Vienna). Nucl. Phys.; B22: No. 2, 412-22(1970).

While the occurrence of anomalies in the perturbation theoretical treatment of certain generalized Ward identities is by now a generally recognized fact, the non-trivial question is still open, how certain n-point functions which appear in these relations, should be connected with observable quantities. As a first step the problem is simplified by allowing only one "foreign" operator in a simple renormalizable field theory, i.e. a local combination of field operators which is not contained among the quantities, rendered finite automatically by the renormalization of the S-matrix. It is found from examples that some counter-terms must be present and therefore as an extreme possibility the cancellation of all anomalies by appropriate counter-terms is conjectured, although this is paid for in certain cases by the appearance of singularities in the redefined matrix elements of the foreign operators. (auth)

59573 STRONG CORRELATION BETWEEN THE CHERENKOV EFFECT AND CERTAIN PROPERTIES OF THE PHOTON-TACHYONS OF THE DISAPPEARING FRESNEL WAVE. Vigoureux, J. M. (Reims Univ.). Compt. Rend., Ser. B; 272: No. 24, 1336-9(14 Jun 1971). (In French).

A strong formal analogy between the coherence relation of the Cherenkov effect and Fresnel's total reflection laws is presented. This analogy together with previous results demonstrate the relation between this effect and that of absorption–emission of momentum–energy quanta in the disappearing Fresnel wave considered previously for free electrons and atomic dipole transitions. A strong analogy is also demonstrated between the Cherenkov effect associated with charged particles moving in a medium and the disappearing wave phenomena occurring between two plane interfaces. (France)

59574 INVARIANT PERTURBATION THEORY FOR NONLINEAR CHIRAL LAGRANGIAN. Slavnov, A. A.; Faddeev, L. D. (Mathematics Inst., Moscow). Teor. Mat. Fiz.; 8: No. 3, 297-307(Sep 1971). (In Russian).

The perturbation theory for nonlinear chiral Lagrangians is constructed in terms of invariant quantities which do not depend upon parametrization. (auth)

59575 SOME PROPERTIES OF THE LEE MODEL. I. Dadashev, L. A. (Inst. of Physics, Baku, USSR). Teor. Mat. Fiz.; 8: No. 3, 308-23(Sep 1971). (In Russian).

The Lee model with the Hamiltonian introduced previously is considered. The explicit dependence of the resolvent on τ matrices is found, and it is shown that the problem of expansion of the resolvent over normal products can be reduced to that of the inversion of a certain operator depending on Bose operators only. On the basis of the formula obtained qualitative conclusions about the spectrum of the Hamiltonian can be drawn. (auth)

59576 VACUUM DEGENERATION FOR A CHARGED SCALAR FIELD WITH THE SELF-INTERACTION $H' = g\int(\varphi^* \varphi)^2 dx$ IN THE CASE OF ONE SPATIAL DEGREE OF FREEDOM. Zastavenko, L. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 8: No. 3, 335-42(Sep 1971). (In Russian).

The vacuum degeneration is studied in the quantum theory of a charged scalar field with the self-interaction $H' = g\int(\varphi^* \varphi)^2 dx$ in the case of one spatial degree of freedom. Besides the Goldstone particle with the rest mass equal to zero, there is another particle with the nonzero rest mass, which decays into an even number of particles with zero rest mass. The impossibility of the decay into an odd number of particles is connected with the existence of a motion integral of the parity type; the particles with the zero and nonzero rest mass belong to the eigenvalues of this integral equal to +1 and −1 respectively. (auth)

59577 THREE-DIMENSIONAL COVARIANT FORMULATION OF THE THREE-BODY PROBLEM IN QUANTUM FIELD THEORY. Vinogradov, V. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 8: No. 3, 343-53(Sep 1971). (In Russian).

On the basis of the three-dimensional formulation of quantum field theory the relativistic analog of the Faddeev equations for the scattering amplitude is obtained. The system satisfies the three-body unitarity and the correspondence principle. (auth)

59578 CONNECTION AND QUANTUM FIELD THEORY IN A CURVED SPACE–TIME. Geronimi, Christian. Compt. Rend., Ser. A; 272: No. 26, 1764-6(28 Jun 1971). (In French).

The introduction of a connection relative to the Lie algebra of the P(4) Poincare group allows the Schroedinger scheme to be generalized. (France)

59579 REGGE CUTS AND THE EIKONAL APPROXIMATION IN FIELD THEORY. II. Nicoletopoulos, P.; Prevost, M. A. L. (Univ. Libre, Brussels). Nuovo Cim.; 5A: No. 3, 357-91(1 Oct 1971).

The mechanisms responsible for obfuscating the true eikonal content of individual Feynman graphs are examined. These complications originate in each case from a class of intermediate states which cancel ultimately upon summation of the relevant criss-crossed sets. All fractions of the eikonal stem from nonleading behavior of nonplanar graphs. The characterization of intermediate states leads in a natural way to a counting procedure which accounts for all the eikonal contributions of criss-crossed ladder plus Born exchange iterations in ϕ^3 theory. (auth)

59580 GENERALIZATION OF THE COOK FORMALISM FOR FOCK SPACE. Schroeck, F. E. Jr. (Florida Atlantic Univ., Boca Raton). J. Math. Phys. (N. Y.); 12: No. 9, 1849-57(Sep 1971).

The Cook formalism for Fock space is extended by finding additional properties of the creation and annihilation operators and by giving a rigorous definition of the second-quantized form for n-body operators (for any n). Properties of these second-quantized operators are given, including an expansion in terms of the creation and annihilation operators. (auth)

59581 CONVERGENT EXPANSION FOR THE RESOLVENT OF: φ^4: $_{1+1}$. Federbush, Paul (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.); 12: No. 10, 2050-1(Oct 1971).

For the model theory, $N + \lambda\int: \varphi^4: dx$ in a box, a convergent expansion of the resolvent is exhibited. This also provides another proof of boundedness below for the model. (auth)

59582 COVARIANT DERIVATIVES OF INFINITE-DIMENSIONAL FIELDS. Bender, Carl M. (Massachusetts Inst. of Tech., Cambridge); Griffiths, David J. J. Math. Phys. (N. Y.); 12: No. 10, 2151-6(Oct 1971).

It is shown that a field which transforms irreducibly under the homogeneous Lorentz group admits four kinds of covariant derivatives–gradient, divergence, and two species of curl. These derivatives are constructed explicitly for both finite- and infinite-dimensional representations. Physical applications are discussed. (auth)

59583 BILOCAL FIELD OPERATOR DESCRIBING AN ARBITRARY TWO-PARTICLE STATE BY MEANS OF ONE-PARTICLE STATES. Lukierski, J. (Univ., Wroclaw). Lett. Nuovo Cim.; 2: No. 15, 784-8(9 Oct 1971).

A model of quantized free bilocal field is proposed for describing an extended particle with infinite extension, but with one-particle states having identical parametrization as the two-particle state. (L.B.S.)

59584 DIFFERENTIAL LIE AND TEST RELATIVISTIC PARTICLES. Sokol'skii, A. A. (Belorussian State Univ., Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 2, 118-21(1969). (In Russian).

The question of the inference from the principle of least action of covariant equations of motion for a relativistic test particle is studied. With the help of differentials Lie equations were obtained correct for arbitrary affine transfer. A number of special cases were examined. (tr-auth)

Gravitation and General Relativity

Refer also to abstracts 58664, 58673, 59238, and 59531.

59585 DESER–LAURENT THEORY OF GRAVITATION AND OTHER TOPICS. Mansbach, Peter Allen. Waltham, Mass.; Brandeis Univ. (1971). 277p. University Microfilms Order No. 71-20,339.

Thesis.

XUM

The predictions of a linear theory of gravitation recently proposed by S. Deser and B. Laurent (DLT) are investigated. After reviewing their formulation of the theory, and the point-mass solution which to first order gives the same results for the four tests as general relativity (GR), the nature of the Schwarzschild singularity in DLT is examined and found much more serious than in GR. Next two possible schemes are considered for coupling the DLT field to matter. The first reproduces the GR behavior of all nongravitational objects and fields; the second is fully linear. Both agree to first order in the field $\phi_{\mu\nu}$. It is shown that the second coupling scheme no longer predicts that light follows null geodesics of the effective metric, and later it is also shown (by means of kinetic theory) that, as currently formulated, it does not predict an isotropic pressure (perfect fluid property) for an ideal gas. Next a Lagrangian is derived for a perfect fluid and static, spherically-symmetric solutions are sought. Using the first coupling scheme the equations can be solved only for weak fields; the solution is given up to second order. With the second coupling scheme one can go further; but as remarked above, an ideal gas is not a perfect fluid in this scheme. In both cases $1/r^3$ terms appear in the exterior effective metric. These are shown not to affect the predictions for the four tests until second order, well beyond current technological ability to detect. Then an idealized nonstatic model is considered, namely a pressure-free shell undergoing gravitational collapse. It was hoped to answer the question of whether a Schwarzschild singularity (or an infinite-density singularity) forms; however, it was not possible to proceed far enough, in the time available. The velocity of the shell for a time exceeds c, the gravitational velocity (but not the speed of light). The shell does fall inside its Schwarzschild radius; but whether it remains there long enough for a singularity to form one does not know. One digresses to discuss kinetic theory in general relativity, partly to lay the groundwork for the kinetic theory in DLT, but also in the hope that a manifestly covariant formulation could be presented, in this there was failure, although some of the problems were clarified. Also a derivation of a general rate of formation of binary stars (or analogous astrophysical configurations) through the mechanism of three-body gravitational interaction is included. Comparison with observation indicates that this three-body mechanism could not have been the dominant one for the formation of binaries during any galactic epoch. However, a mechanism is suggested for planetary capture of asteroids, with an inner satellite serving as the third body, that might explain the origin of Jupiter's outer moonlets. (Diss. Abstr.)

59586 SUPPLEMENTARY TRIVIAL EQUATIONS IN THE PENROSE-NEWMAN FORMALISM. **Herrera, Alfredo; Papapetrou, Achille (Univ., Paris). Compt. Rend., Ser. A; 272: No. 26, 1756-9(28 Jun 1971). (In French).**

It has already been demonstrated that certain identities permit, within the Newman–Penrose formalism, the separation of the field equations into principal, supplementary, and trivial equations. An incomplete discussion (A. Papapetrou, Ann. Inst. Henri Poincare, 13, 1970, p. 271) demonstrated the existence of at least one trivial equation. This discussion is completed taking into account all the identities; five trivial equations are obtained. (France)

59587 SOLUTIONS OF THE GRAVITATIONAL–SCALAR FIELD SYSTEM. **Higbie, James Howard. Waltham, Mass.; Brandeis Univ. (1971). 170p. University Microfilms Order No. 71-20,332.**

Thesis.

The system gravitation–electromagnetic field–massless scalar field is considered. The electromagnetic field is the ordinary minimally-coupled one. The gravitational and scalar fields considered are of three types: ordinary scalar field minimally coupled to Einstein gravitation, conformally-invariant scalar field nonminimally coupled to Einstein gravitation, and Brans-Dicke gravitation with its associated scalar field. A spherical thin-shell distribution of "dust" with bare mass m_0, electric charge e, and (except in the Brans-Dicke case) scalar charge f, but no macroscopic pressure terms or Poincaré-type forces provides a realistic particle-like source for the fields involved. The initial-value problem is solved for initial-value data appropriate to a particle-like solution. Thus a class of spherically symmetric initially static solutions are obtained. The presence of the scalar charge on the source gives rise to unexpected behavior of these solutions. In particular for a given set of source parameters m_0, e, f and isotropic coordinate radius ϵ, either zero, one, two or perhaps more solutions may exist. They may be separated into a branch of normal solutions which go over into the $f = 0$ solutions as $f \rightarrow 0$, and a branch of anomalous solutions which go over into an essential singularity as $f \rightarrow 0$. For m_0 and f fixed and $e = 0$ there is no point limit $\epsilon \rightarrow 0$. Because of the absence of the scalar charge in the source, none of this behavior occurs in the Brans-Dicke case. For $e \neq 0$ however some unusual behavior occurs which is not the result of the scalar source charge and consequently is present in all three cases: Certain ranges of source parameters, roughly given by $m_0 < 2\kappa^{-1/2} e$, do not give rise to any solutions. A consequence of this is that nontrivial static solutions do not exist for $\infty > \epsilon > 0$. For $f = e = 0$, the $\epsilon \rightarrow 0$ limit yields a static and flat-exterior solution, both in Einstein and Brans-Dicke theory. In the Einstein case the dressed mass vanishes as $\epsilon^{1/2}$ and the invariant radius remains nonzero $\sim m_0$. In the Brans-Dicke case however, the dressed mass vanishes faster than $\epsilon^{1/2}$ and the invariant radius vanishes as well. A point particle with only gravitational interactions might be said to vanish more thoroughly in Brans-Dicke theory therefore, and in this sense it could be called more "Machian" than general relativity. Nontrivial particle-like solutions are next sought, by requiring the solutions to be static with $\epsilon < \infty$ and nonflat exterior. For all three cases, it is found that the only such solution is one with Reissner-Nordstrom exterior and vanishing exterior scalar field. The scalar charge (or Brans-Dicke coupling constant ω) has no exterior effect in these solutions, although in the Brans-Dicke case a renormalization of κ is required which results in a slight change of the mass for a given charge. The scalar charge (or ω) does affect the invariant radius and the possible range of m_0, however. The fact that no particle-like solutions exist with nonvanishing exterior scalar field could be used to argue that sources of the massless scalar field do not exist in nature. (Diss. Abstr.)

59588 COORDINATE-FREE RELATIVITY. **Hudgin, Richard Henry. Stanford Calif.; Stanford Univ. (1970). 130p. University Microfilms Order No. 71-12,923.**

Thesis.

Physicists have many assumptions which, because of the extreme simplifications they allow, go unchallenged and unexplored. One of the most neglected is the coordinate system. How convenient to have a 1-1 continuous, twice differentiable map of the universe onto 4-space! A Riemannian metric and geodesic motion further restrict the generality and are the starting point for many theories. If one is to believe Mach's principle in its most general form—that the properties of matter and energy are determined by the matter-energy distribution in the universe—then the validity of a coordinate system description with its usual nice properties should be a result of the theory, not an axiom. This is one goal. With these ideas in mind, the purpose is twofold: first, to axiomatize Riemannian geometry independently of a coordinate system and second, to point out the natural generalizations of a Riemannian manifold which reveal themselves. In place of a coordinate system, the set $P = \{i, j, k, \ldots\}$ of all test particles and their communication functions ϕ_{ij} is postulated. Physically, one is assuming a real, ordered parametrization of a test particle's experience. (Proper time would be an example in special relativity.) The $\phi_{ji}(s_i) = s_j$ is a function of i's time s_i and, physically, is interpreted as the soonest arrival time s_j of a signal sent from particle i at s_i to particle j. One could imagine light pulses going from particle to particle. This communication function between test particles was used previously in a treatise on kinematic relativity, and some of the properties of the communication function in general relativity were also investigated. In neither case, however, was the concern with generalizing the coordinate system. The problem now is to formulate axioms which correlate the communication functions of all the test particles in such a way that Riemannian geometry emerges. It should be stressed that nowhere in the axioms are the terms metric, geodesic, or coordinate patch used. These are derived concepts. Possible generalizations are discussed which will look like a Riemannian manifold over large distances and times, but which fall apart over short intervals. The mathematical apparatus required to replace the coordinate system and to deal with the generalizations is not broached, but the hope is that future developments will soon resolve this question. (Diss. Abstr.)

59589 NOTE ON NEUTRINO-GRAVITATIONAL FIELDS WITH POSITIVE ENERGY DENSITY. **Griffiths, J. B.; Newing, R. A. (University Coll. of North Wales, Bangor). J. Phys., A (London); 4: No. 5, L81-2(Sep 1971).**

Neutrino-gravitational fields with positive energy density are considered. A special case of these fields appeared to introduce some complications. It is shown here that this case may be removed by a simple transformation. (auth)

59590 SIMPLE RELATIVISTIC THEORY OF GRAVITATION. **Coleman, C. J. (Imperial Coll. of Science and Tech., London). J. Phys., A (London); 4: No. 5, 611-16(Sep 1971).**

It is shown that a particular theory with a Lorentz-invariant scalar potential ϕ and a simple gravitational metric involving ϕ

XUM

leads to the same results for the three Einstein tests as General Relativity. (auth)

59591 GENERALIZED FIELD EQUATIONS IN GENERAL RELATIVITY. Tupper, B. O. J. (Univ. of New Brunswick, Fredericton); Phillips, G. W. J. Phys., A (London); 4: No. 5, 597-610(Sep 1971).

Generalizations of Einstein's field equations in general relativity are derived by considering variational principles in which the components of an ennuple, or tetrad, are the quantities which undergo variation. The conservation law for the field equations is established and the weak field approximations discussed. The equations are solved by the method developed in a previous article (1970). Many solutions are obtained, all of which are inferior to the Schwarzschild solution. (auth)

59592 STUDY OF GENERAL RELATIVITY IN CANONICAL FORM. Klotz, Frederick S. Syracuse, N. Y.; Syracuse Univ. (1970). 116p. University Microfilms Order No. 71-21,524. Thesis.

The positivity and constraint relations that arise when the theory of general relativity is put in canonical form are examined. These restrictions are viewed as an indication that the original canonical variables are not appropriate for the theory, and by means of a canonical transformation new dynamical variables it is sought to introduce which are not subject to such conditions. When canonical variables must obey inequalities such as the positivity conditions, the "good" phase space generators of transformations that preserve these inequalities constitute the most natural dynamical variables for the theory. It is shown that when all canonical variables are chosen so as to satisfy the "good" criterion, the original inequalities disappear from the canonical formalism. These ideas are applied to a model theory based on the Lagrangian for the Kasner solutions to the field equations of general relativity. The use of "good" variables has the additional advantage of substantially simplifying the form of the Hamiltonian, and the dynamical equations reduce essentially to those of a massless free particle in two dimensions. But when the analogous canonical transformation in general relativity is performed, it is found that, although the positivity conditions no longer appear, the form of the constraints becomes more complicated. One can, however, simplify and remove the constraints by introducing quantities with a direct co-ordinate independent geometrical significance as canonical variables. The most convenient such quantities are scalars. Three phase space functions are explicitly constructed at each point of the manifold which behave as scalars under transformations involving the spatial co-ordinates only. One can think of these scalars as defining an intrinsic co-ordinate system on each t = constant hypersurface. With the spatial intrinsic co-ordinates of the t = constant hypersurfaces of the manifold as canonical variables, the spatial constraints are reduced to simple algebraic equations which one can solve and eliminate. One may treat the remaining constraints in a similar manner by introducing an intrinsic time variable separately in the canonical set. Alternately, with the much more complicated intrinsic co-ordinates of the entire manifold as canonical variables, all the constraints are reduced to simple algebraic equations which one can solve and eliminate. In this way a constraint free form for the canonical field equations of general relativity is found. Finally, the meaning of these results for the quantization program is discussed. (Diss. Abstr.)

59593 SOME REMARKS ON THE NEWMAN-PENROSE FORMALISM. Papapetrou, Achille (Paris Univ.). Compt. Rend., Ser. A; 272: No. 23, 1537-40(7 Jun 1971). (In French).

Expressions obtained for the gravitational field using classical theory are compared with those developed in the Newman–Penrose formalism. (France)

59594 CAUCHY PROBLEM FOR THE NONLINEAR BOLTZMANN EQUATION IN GENERAL RELATIVITY. Bancel, Daniel (Paris Univ.). Compt. Rend., Ser. A; 272: No. 25, 1685-8(21 Jun 1971). (In French).

The Cauchy problem is studied for the nonlinear Boltzmann equation in the framework of the general relativity. A local theorem of existence and unicity is demonstrated using energy inequalities in Sobolev-type weighted spaces. (France)

59595 SINGULARITY IN THE GENERAL THEORY OF RELATIVITY. Maldybaeva, E. Ya. (Inst. of Astrophysics, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR; 14: No. 6, 18-21(1971). (In Russian).

The nature of the divergence in the general theory of relativity was explored. In the nonstationary field the existence of causality is equivalent to the presence of paradoxes in the dynamic theory of infinite systems constructed on the principle of causality. The initial hypersurface is proposed as uncharacteristic. The Hamiltonian formalism serves to express the principle of causality. The inference concerning the inevitability of singularity belongs to the general problem of Kosh, the erection of which is confirmed in cosmology. (K.S.W.)

59596 ON THE EQUIVALENCE OF GRAVITATIONAL RED SHIFT AND TEMPERATURE SHIFT IN THE MOESSBAUER EFFECT. Gupta, G. P.; Lal, K. C. (Lucknow Univ., India). Phys. Lett.; 36A: No. 5, 421-2(27 Sep 1971).

An expression for the Moessbauer fractional energy shift for an atomic oscillator was derived on the basis of the equivalence principle and is shown to be identical with those derived previously. (auth)

59597 TWO RELATIVISTIC MATTER DISTRIBUTIONS OF RADIAL SYMMETRY. Kuchowicz, B. (Univ., Warsaw). Indian J. Pure Appl. Math.; 2: No. 2, 297-300(Apr 1971).

Two new solutions of Einstein's field equations are obtained, one in canonical Schwarzschild coordinates and the other in isotropic coordinates. The metric tensor components and matter density are expressed in terms of simple elementary functions and their derivatives. (auth)

59598 TRAJECTORIES EQUATIONS IN A SPACE WITH A NONRIEMANNIAN CONNECTION. Clerc, Rene-Louis (Univ., Toulouse). Compt. Rend., Ser. A; 272: No. 26, 1760-3(28 Jun 1971). (In French).

As a continuation of a previous work (Comptes rendus, 272, serie A, 1971 p. 1145), the nonsymmetrical connection used is determined as a function of the independent variables $g_{\alpha\beta}$ and $S^{\alpha}_{\beta\gamma}$. The conservation identities are stated and the equations for the current lines are deduced from them; they resemble those of an electromagnetic field but have certain mass independent terms; such terms can be related to the effect of inertial spin. (France)

59599 QUANTIZATION OF PARTICLES IN THE EXTERNAL GRAVITATIONAL FIELD. Vilkovyskii, G. A. (All-Union Scientific Research Inst. of Phycial-Technical and Radiotechnical Measurements, Moscow). Teor. Mat. Fiz.; 8: No. 3, 359 68 (Sep 1971). (In Russian).

The quasiclassical approximation for the quantum particle in the external gravitational field is studied. The ambiguity in the quantum Hamiltonian is discussed in this connection. Feynman quantization of the particle in the external gravitational field is performed. (auth)

59600 GENERAL FORMULATION OF THE TETRAD VARIATIONAL PRINCIPLE OF EINSTEIN'S GRAVITATIONAL THEORY. Davis, W. R. (North Carolina State Univ., Raleigh). Nuovo Cim.; 5B: No. 2, 153-64(11 Oct 1971).

It is shown that a form of the tetrad variational principle of Einstein's gravitational theory exists that is more general than the formulation given by Møller. This formulation includes, in addition to the usual field equations, the further field equations $\gamma_k^{ji} + \gamma_k^{ij} = 0$ (where γ_{ijk} is the associated tensor to the Ricci coefficients of rotation) that determine the tetrad field as defining a Riemannian space–time. It is pointed out that the more general treatment provides an appropriate starting point for the anholonomic formulation of Einstein's theory which, accordingly, is discussed briefly in this context. Finally, the modified tensorial tetrad superpotentials following for the holonomic and anholonomic forms of the general variational principle are considered. (auth)

59601 MASSIVE AND MASS-LESS YANG–MILLS AND GRAVITATIONAL FIELDS. van Dam, H.; Veltman, M. (Univ., Utrecht). Nucl. Phys.; B22: No. 2, 397-411(1970).

Massive and massless Yang–Mills and gravitational fields are considered. It is found that there is a discrete difference between the zero-mass theories and the very small, but non-zero mass theories. In the case of gravitation, comparison of massive and massless theories with experiment, in particular the perihelion movement of Mercury, leads to exclusion of the massive theory. It is concluded that the graviton mass must be rigorously zero. (auth)

59602 TRAPPED SURFACES AND THE DEVELOPMENT OF SINGULARITIES. Pajerski, David Walter (California State Coll., California, Pa.); Newman, Ezra T. J. Math. Phys. (N. Y.); 12: No. 9, 1929-37(Sep 1971).

The study of singularities in general relativity was given a strong impetus by a topological approach due to Penrose and others, and powerful theorems concerning their existence have been developed. In particular a theorem by Penrose states that under certain conditions the existence of a trapped surface in a

XUM

space—time guarantees that singularities will develop. Using the spin coefficient formalism one generalizes from the Schwarzschild solution, and the existence of a wide class of solutions possessing such trapped surfaces is proven by displaying the solutions to terms linear in a certain null coordinate. Then, using an asymptotic procedure, the method is generalized to include a class of solutions possessing "asymptotically trapped surfaces." (auth)

59603 QUADRATIC LAGRANGIANS IN GENERAL RELATIVITY. **Folomeshkin, V. N. (Inst. of High Energy Physics, Serpukhov, USSR).** Commun. Math. Phys.; 22: No. 2, 115-20 (1971).

The solutions of the general relativity equations with quadratic Lagrangians $R_{iklm}R^{iklm}$, $R_{ik}R^{ik}$, R^2 are studied. It is shown that nontrivial Euclidian (at $r \rightarrow \infty$) solution of the theory equations does not exist when $T \neq 0$ (T is a trace of the energy-momentum tensor of matter). The Schwarzschild solution is not an external part of a total solution when $T \neq 0$. Under condition $T = T = 0$ Lagrangians $R_{iklm}R^{iklm}$, $R_{ik}R^{ik}$ lead to the identical field equations, so there exist the only quadratic Lagrangian and the only field equations. This equation has a solution with an external part being a standard Schwarzschild solution for the statical spherically symmetric case. (auth)

59604 SOURCES AND DETECTION OF GRAVITATIONAL RADIATION OF HIGH FREQUENCY. **Halpern, L. (Univ. of Brussels).** Nature (London) Phys. Sci.; 233: No. 36, 18(6 Sep 1971).

Reference is made to recent experimental work from which evidence was obtained for pulses of gravitational radiation of intensity far exceeding all expectations. This work was designed to detect radiation in the low frequency domain, of the order of kilocycles, where quantum phenomena are not observable. There was no apparent justification to recommend experimental work concerned with high frequency, as such radiation would be of far too low intensity. It was argued previously, however, that new results in the low frequency domain have altered the situation so that even the detection of radiation of high frequency should be seriously considered. Such experimental work would be of interest even if it turned out that no gravitational radiation exists in the domain that can be covered. (UK)

59605 OBSERVABLE EFFECTS OF TORSION IN SPACE—TIME. **Ponomariev, V. N. (Univ., Warsaw).** Bull. Acad. Pol. Sci., Ser. Sci., Math., Astron. Phys.; 19: No. 6, 545-50 (1971).

The simplest and the most natural generalization of Einstein's theory, based on the assumption of nonvanishing torsion, is considered. The possibility of taking a manifold with torsion as a model of space—time was put forward previously. It is shown that the tensor of torsion has an influence on the geodetic lines under the assumption that the connection is metric. The effect of torsion on the perihelion motion of the orbits of planets and on bending of rays of light is considered. (auth)

59606 RADIATION SCATTERING IN EINSTEIN—MAXWELL THEORY. **Couch, W. E. (Univ. of Pittsburgh); Hallidy, W. H.** J. Math. Phys. (N. Y.); 12: No. 10, 2170-5(Oct 1971).

A linearized Einstein—Maxwell field composed of a mass monopole, a radiating mass quadrupole, a Coulomb field, and radiating electromagnetic dipole and quadrupole fields is examined to second order. If the first-order radiation is a pulse of finite duration, then the only second-order radiation present after the pulse has turned off is due to interactions involving the mass monopole. All other interactions contributing to the second order produce no such scattered radiation. At third order, the dipole—dipole-mass interaction is found to give rise to scattered radiation. (auth)

59607 GRAVITATIONAL WAVE ASTRONOMY: AN INTERIM SURVEY. **Fellgett, P. B. (Univ. of Reading, Eng.); Sciama, D. W.** Radio Electron. Eng.; 41: No. 8, 391-7(Sep 1971).

The concept of gravitational radiation is introduced and the experiments of Weber are described. The magnitude and nature of the phenomenon are discussed in the light of Einstein's theory of relativity. The basic theory of a detector is developed and the means of realization are indicated. Investigations are proceeding along these and parallel lines in many parts of the world, but no definitive results have yet been reported. (auth) (UK)

59608 RIEMANNIAN STRUCTURE OF SPACE—TIME AS A CONSEQUENCE OF A MEASUREMENT METHOD. **Castagnino, Mario A. (Univ., Buenos Aires).** J. Math. Phys. (N. Y.); 12: No. 10, 2203-11(Oct 1971).

Following a previous graphical method it is shown analytically that if the space—time paths of all particles and light pulses are known one can deduce the connection and the metric of the space—time manifold. Specifically if such space—time paths fulfill some reasonable physical hypotheses, it is proved that space—time is a Riemannian manifold. To reach this conclusion a new definition of parallelism is introduced, based only on ideal experiments. This parallelism is entirely different from the ordinary parallel transfers, if the manifold is non-Riemannian; therefore it opens new ways of modifying gravitational theory. (auth)

Scattering Theory

Refer also to abstracts 59220 and 59577.

59609 (KFKI-71-39) ON THE USE OF NEGATIVE TIME-LIKE STATES. **Szego, K. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest).** [1970]. 15p. Dep. NTIS (U. S. Sales Only).

It is shown that the analytic continuation of the quasi-elastic scattering amplitude into the different channels can lead to negative energy time-like states. Its advantages and difficulties are discussed. (auth)

59610 GENERALIZED EIKONAL APPROXIMATION, IMPACT PHASE AVERAGING, AND MULTIPLE HARD COLLISIONS. **Hahn, Yukap (Univ. of Connecticut, Storrs).** Nucl. Phys.; B34: No. 1, 209-26(1971).

The phase averaging procedure is developed in detail to give a systematic treatment of the high-energy scattering amplitudes in the eikonal approximation. Close connection between the eikonal approximation and the phase averaging is stressed. A generalized form of the propagator modification is proposed which approximately incorporates all the quadratic terms in the internal line momenta; amplitudes of the Glauber-type, in which the impact phases are evaluated along the average momentum, are shown to follow as special cases. In an attempt to improve the eikonal approximation at large angles, the amplitudes with double-hard collisions are derived, where the role of propagators is emphasized. Extensions of the formalism to relativistic case of scalar particle-scalar coupling are considered only in the generalized ladder approximation. Essential differences between the symmetrized and the DWBA amplitudes are pointed out. (auth)

59611 SIGNATURE, FACTORISATION, AND UNITARITY IN THE MULTI-REGGE MODEL. **Halliday, I. G. (Imperial Coll. of Science and Tech., London).** Nucl. Phys.; B33: No. 1, 285-302 (1971).

It is shown by continuation from the Symanzik region that the $2 \rightarrow 4$ multi-Regge amplitude in ϕ^3 perturbation theory factorises into signature terms and vertex terms. By using the implied normal threshold structure it is shown how the $2 \rightarrow 4$ particle unitarity equation becomes an identity if the $2 \rightarrow 4$ and $2 \rightarrow 3$ unitarity equations are satisfied at high energies. This solves a long standing problem in the multi-peripheral bootstrap. (auth)

59612 RASSEYANIE, REAKTSII I RASPADY V NERELYATIVISTSKOI KVANTOVOI MEKHANIKE. (Scattering, Reactions, and Disintegrations in Nonrelativistic Mechanics). **Baz, A. I.; Zel'dovich, Ya. B.; Perelomov, A. M.** Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1971). 544p.

Problems in quantum mechanics are considered, as they relate to atomic and nuclear processes, and the attempt is made to fill the gap between the textbook and the original literature. Discrete and continuous spectra, analytical properties of wave functions, and the quasi-classical approach are described. Several chapters deal with the quasi-stationary state, multichannel systems, and the three-body problem. Other topics considered of importance are quasi-classical properties of a degenerate Fermi gas, the Green's function of the Schroedinger equation, unstable systems, and threshold phenomena. (K.S.W.)

59613 SINGULARITIES OF THE S-MATRIX. **Burkhardt, H.; Riordan, F. (Univ. of Birmingham, Eng.).** pp 133-58 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

59614 S-MATRIX THEORY. **Mandelstam, S. (Univ. of California, Berkeley).** pp 189-201 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

59615 APPLICATIONS OF REGGE POLES TO SHORT-WAVELENGTH SCATTERING. Nussenzveig, H. M. (Univ. of Rochester, N. Y.). pp 203-32 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

59616 SCATTERING OF UNSTABLE PARTICLES. Peierls, R. F. (Brookhaven National Lab., Upton, N. Y.). pp 259-67 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

59617 CONFIGURATION-SPACE VIEW OF HIGH-ENERGY SCATTERING. Brandt, Richard A. (New York Univ., N. Y.). Phys. Rev., D; 4: No. 2, 444-50(15 Jul 1971).

The amplitude for the reaction $A + C \to B + D$ is considered, where A and B are scalar currents and C and D are on-shell scalar particles. Scaling behavior and Regge behavior are assumed, and these behaviors are implemented on integral representations with suitable spectral functions. It is shown that the leading light-cone singularity determines the trajectory function and thus provides a configuration-space view of high-energy behavior. (L.B.S.)

59618 TWO-REGGEON EXCHANGE CONTRIBUTIONS TO HADRON SCATTERING AMPLITUDES AT HIGH ENERGY. Quigg, Chris. Berkeley, Calif.; Univ. of California (1970). 191p. University Microfilms Order No. 71-20,888.

Thesis.

Regge cuts are discussed from a phenomenological point of view. Some attempts to derive amplitudes with Regge cuts are reviewed. A phenomenological amplitude for the Regge cut from two-Regge exchange is written down in a form that manifestly satisfies s-u crossing. The amplitude is formulated in terms of s-channel helicity partial-wave amplitudes, so the Reggeization of s-channel helicity amplitudes is discussed as a technical simplification. Implications of Regge cuts for various duality-breaking schemes (and vice versa) are summarized. Brief remarks are made on two-Reggeon cuts and exotic exchange. These include model calculations of the $(P' + \rho) \otimes (P' + \rho)$ cut in $\pi\pi$ scattering, and of the single-meson-exchange "forbidden" reaction $K^-p \to K^+\Xi$. (Diss. Abstr. Int., B)

59619 MULTIVARIABLE EXPANSION OF SCATTERING AMPLITUDES, CROSSING SYMMETRY OF PARTIAL WAVES, AND TESTS OF VARIOUS CROSSING SYMMETRIC MODELS. Modjtehedzadeh, Mohammed. Syracuse, N. Y.; Syracuse Univ. (1970). 130p. University Microfilms Order No. 71-21,525.

Thesis.

Double partial wave expansion of the scattering amplitude of spinless particles was extended to include particles with arbitrary mass and spin assignment. Expansion is quasidiagonal in angular momentum and displays the correct threshold and pseudo-threshold behavior of the partial wave amplitudes. Together with the crossing symmetry requirement, this expansion yields an infinite array of finite dimensional crossing relations for the partial waves. This expansion is further generalized to the cases of multiparticle scattering processes. Multivariable expansion of the scattering amplitude was obtained. Special applications of the four- and five-particle scattering processes were made and for the case of four particle scattering previous results are obtained. The tests of various crossing symmetric models are considered. Three models suggested previously were investigated by making use of Balachandran–Blackmon inequalities. It was shown that some sub-set of values for the parameters of the above mentioned models can be selected in which Balachandran–Blackmon inequalities are satisfied. (Diss. Abstr. Int., B)

59620 UNIFORMIZATION IN A SOLUBLE PARTIAL WAVE MODEL. Choudhary, A. R.; Jones, R. B. (Queen Mary Coll., London). Nucl. Phys.; B22: No. 2, 343-57(1970).

A non-relativistic partial wave model based on elastic unitarity and a simple left-hand cut is studied. Although the usual N/D method leads to singular integral equations, the model can be solved exactly in terms of hypergeometric functions by use of a differential equation technique. This differential equation approach also reveals the existence of a manifold of other functions which solve the basic discontinuity relations without, however, obeying dispersion relations. Since the model is marginally singular, the exact solutions give examples of amplitudes of non-integer CDD class. Furthermore, the amplitude can be globally uniformized by use of the elliptic modular function. Because of this circumstance, a comparison can be made of approximation schemes which differ by their treatment of the underlying Riemann surface. The conclusion is that the exact solution of the model is best approximated in terms of the uniformizing variable, a procedure which maintains the correct Riemann surface at each stage of approximation. (auth)

59621 EXTRAPOLATION OF SCATTERING AMPLITUDES. IV. EXTRAPOLATION OFF A PART OF THE BOUNDARY TO THE REST OF THE BOUNDARY. Presnajder, P. (Comenius Univ., Bratislava); Pisut, J. Nucl. Phys.; B22: No. 2, 365-84 (1970).

The problem of extrapolating an amplitude (or a form factor) off a part of the boundary of the analyticity region to the rest of the boundary is considered. To obtain a stable procedure the extrapolation is made to average values over an arc on the boundary. In defining the average value weight functions analytic in the analyticity region of the amplitude are introduced. The expression for the average value is then simply obtained from the Cauchy theorem applied to the product of the weight function and the amplitude. The optimal weight functions (corresponding to a given arc) are found for cases of simply and doubly connected analyticity regions. For the latter case (in appendix C) the optimal solution to the problem of extrapolation to points inside the analyticity region is also presented. (auth)

59622 KIRKWOOD–SALTZBURG EQUATIONS FOR THE COEFFICIENT FUNCTIONS OF SCATTERING MATRIX. Petrina, D. Ya.; Skripnik, V. I. (Theoretical Physics Inst., Moscow). Teor. Mat. Fiz.; 8: No. 3, 369-80(Sep 1971). (In Russian).

The system of equations of the Kirkwood–Saltzburg type is deduced for the coefficient functions of scattering matrix in the Euclidean region. It is proved that the solutions of the equations for coefficient functions at infinite volume exist for the models of real scalar field with bounded nonlinear Lagrangians. The analogies between the Euclidean quantum field theory and statistical mechanics are investigated. (auth)

59623 L-WAVE INVERSE SCATTERING PROBLEM. Corbella, Oscar D. (Univ. Nacional, Cordoba, Argentina). J. Math. Phys. (N. Y.); 12: No. 9, 1873-82(Sep 1971).

The inverse scattering problem for the Schrödinger equation is considered. Under certain restrictions on some of the odd derivatives of the potential, one obtains expressions for the values of the potential and its derivatives at the origin, as functions of the phase shift and bound state data for any fixed partial wave. Closed expressions for the first coefficients of the expansion of the potential are obtained. (auth)

59624 ASYMPTOTIC FORM OF THE THREE-PARTICLE SCATTERING WAVEFUNCTION FOR FREE INCIDENT PARTICLES. Nuttall, J. (Texas A and M Univ., College Station). J. Math. Phys. (N. Y.); 12: No. 9, 1896-9(Sep 1971).

It is shown that second-order multiple scattering terms lead, in some directions, to an anomalous term in the asymptotic form of the wavefunction for three free incident particles, which falls off as the inverse second power of distance. The boundary of the region in which this occurs is given, together with the form of the wavefunction near this boundary. (auth)

59625 ZEROS OF DUAL RESONANT AMPLITUDES. D'Adda, A. (Univ., Turin); Sciuto, S.; D'Auria, R.; Gliozzi, F. Nuovo Cim.; 5A: No. 3, 421-32(1 Oct 1971).

Large classes of zeros of multiparticle dual resonant amplitudes are found by fully exploiting the linear relations, first introduced by Plahte, that relate amplitudes correspondingly to different orderings of the external particles. Their connection with duality as well as their generalization to amplitudes with excited particles are discussed. Moreover, at least for the five-point function, the zeros are shown to be a consequence of a larger symmetry than the cyclical one. (auth)

59626 REMARKS ON THE EXISTENCE OF SOLUTIONS OF THE TWO-PARTICLE LIPPMANN–SCHWINGER EQUATION. II. Shastry, C. S.; Rajagopal, A. K. (Louisiana State Univ., Baton Rouge). J. Math. Phys. (N. Y.); 12: No. 10, 2195-8(Oct 1971).

The following is proven: The kernel $K_s^{(l)}$ corresponding to the lth partial wave of the modified partial wave Lippmann–Schwinger equation having symmetric kernel $K_s = V^{½}G_0^+V^{½}$ belongs to the Hilbert–Schmidt (L^2) class for spherically symmetric potential V such that $V(r) \to r^{-\delta}$, $\delta < 2$ as $r \to 0$; $V(r) \to r^{-\eta}$, $\eta > 1$ as $r \to \infty$. For $V(r) = g/r^{\alpha}$, $1 < \alpha < 2$, the kernel K_s of the modified Lipmann–Schwinger equation satisfies $\mathrm{Tr}\{(K_s^{\dagger})^m K_s^m\} < \infty$, if $\alpha > 1 + 1/m$, $m = 2, 3, \cdots$. The above results are valid even for

XUM

positive real energy. It is also shown that for potentials for which both K_s and the kernel $K = G_0^+V$ of the usual Lippmann–Schwinger equation belong to L^2 class, the corresponding off-shell two-particle T matrix $\langle k|T(E + i\epsilon)|k'\rangle$ has a unique limit as $\epsilon \to 0$, $E > 0$. Some important consequences of these results are discussed. (auth)

59627 STRUCTURE OF THE GENERALIZED VENEZIANO AMPLITUDES. I. RADON TRANSFORMS. Wu, Alfred C. T. (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.); 12: No. 10, 2035-6(Oct 1971).

The (tree-graph) generalized Veneziano amplitudes are shown to be boundary values of a new class of generalized hypergeometric functions having the property that they are Radon transforms of products of linear forms. (auth)

59628 STRUCTURE OF THE GENERALIZED VENEZIANO AMPLITUDES. II. POSSIBLE GROUP THEORETIC CONTENT. Wu, Alfred C. T. (Univ. of Michigan, Ann Arbor). J. Math. Phys. (N. Y.); 12: No. 10, 2036-9(Oct 1971).

An attempt is made to generalize a previous result that the beta function (being adopted as a Veneziano formula for four-particle processes) appears as the kernel (in the integral) of the irreducible representation (in the Mellin-transformed space) of the group of 2 × 2 unimodular triangular matrices. It is shown that with a modified multiplier in the Gel'fand–Naimark prescription for the representation of the group of $(n + 1) \times (n + 1)$ unimodular triangular matrices, the (tree-graph) generalized Veneziano amplitude for $(n + 3)$-particle processes is recovered by a limiting procedure. (auth)

59629 EIKONAL APPROXIMATION AND THE MANDELSTAM DIAGRAM. Islam, M. M. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett.; 36B: No. 6, 586-90(18 Oct 1971).

Cheng and Wu's argument that the eikonal approximation fails for the Mandelstam diagram with a Regge pole and a single-particle exchange is shown not to be valid when form factors are included in the single-particle exchange. The failure of the eikonal approximation for this diagram then appears in a completely different way. (auth)

59630 ANOTHER BOUND ON THE ABSORPTIVE PART OF ELASTIC SCATTERING AMPLITUDES. Savit, R. (Stanford Univ., Calif.); Blankenbecler, R.; Einhorn, M. B. J. Math. Phys. (N. Y.); 12: No. 10, 2092-8(Oct 1971).

Via Lagrange multipliers for inequality constraints, an upper bound on the absorptive part of the elastic scattering amplitudes is derived assuming unitarity, a fixed total and elastic cross section, and the condition that the partial waves decrease monotonically with increasing angular momentum. Numerical results are given. (auth)

59631 T MATRIX FOR THE HULTHEN POTENTIAL. Bahethi, O. P.; Guda, M. G. (State Univ. of New York, Buffalo). J. Math. Phys. (N. Y.); 12: No. 10, 2076-80(Oct 1971).

A closed-form expression for the s wave part of the Hulthén potential's T matrix is derived. This expression is used to obtain a simpler result for the terms in the Weinberg series for the T matrix than the results given previously. (auth)

Particle Accelerators

Refer also to abstracts 57783, 57863, 59336, and 59359.

59632 (CONF-711002) PROCEEDINGS [OF] THIRD INTERNATIONAL SYMPOSIUM ON RESEARCH MATERIALS FOR NUCLEAR MEASUREMENTS, GATLINBURG, TENNESSEE, OCTOBER 5–8, 1971. (Oak Ridge National Lab., Tenn.). 322p. Dep. NTIS.

Separate abstracts are prepared for 24 papers. (C.E.S.)

For abstracts of individual papers see: 57345, 57498, 57649–57651, 57723, 57724, 57863, 58179–58184, 58346, 59633–59640, and 59670.

59633 (CONF-711002–, pp 39-46) PREPARATION OF SELF-SUPPORTING, METALLIC FOILS OF ISOTOPIC CHROMIUM. Kuehn, P. R.; O'Donnell, F. R.; Kobisk, E. H. (Oak Ridge National Lab., Tenn.). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

The chromium isotopes ^{50}Cr, ^{52}Cr, ^{53}Cr, and ^{54}Cr are desired as self-supporting foils (targets) for nuclear research. Since the cost of isotopic chromium ranges from \$0.50 to \$4.00/mg and the supply is limited; dependability and material recovery without contamination are important considerations in any process used to form such self-supporting foils. Electrodeposition has proven to be ideally suited for target fabrication using these separated isotopes, since unused chromium can be salvaged with minor loss through simple chemical processing. In addition, targets prepared by this technique are structurally strong, uniform in thickness, and sufficiently pure for most nuclear applications. (auth)

59634 (CONF-711002–, pp 59-69) PREPARATION OF ACTINIDE METAL TARGETS USING SPECIAL CASTING TECHNIQUES. Conner, William V. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Preparation of actinide metal targets produced by reduction of oxides is described. The reduction process produces a button which is rolled or cast to the desired thickness. Casting is the preferred method because less scrap is generated. Tilt-pour casting and injection casting methods are described. (J.R.D.)

59635 (CONF-711002–, pp 91-100) TECHNIQUES USED AT HARWELL IN THE PREPARATION OF STABLE AND ACTIVE NUCLIDE TARGETS. Glover, K. M.; Rogers, F. J. G.; Tuplin, T. A. (Atomic Energy Research Establishment, Harwell (England)). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Preparation of stable isotope and radioisotope targets by cold rolling and vacuum evaporation is described. These techniques are supplemented by die compaction, electroplating, and paint-on deposition. (J.R.D.)

59636 (CONF-711002–, pp 101-7) PREPARATION OF ISOTOPIC ACCELERATOR TARGETS. Heagney, J. M. (Washington Univ., Seattle). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Fabrication of targets using small quantities of isotopic material is discussed. Fabrication methods involving rolling, electrodeposition, and vacuum evaporation are described. Storage of methods for foils are also described. (J.R.D.)

59637 (CONF-711002–, pp 109-15) PREPARATION OF ISOTOPE TARGETS BY HEAVY-ION SPUTTERING. Sletten, Geirr; Knudsen, Per (Copenhagen Univ. (Denmark)). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Information and data are presented which show that heavy ion sputtering is an excellent technique for producing isotope targets of refractory metals and oxides from the point of view of isotope economy. The quality of sputtered targets with respect to uniformity and purity is good, and, in many cases, no alternative method exists for producing such target materials. (auth)

59638 (CONF-711002–, pp 116-21) PREPARATION OF TARGETS OF ALPHA-RADIOACTIVE ISOTOPES. Sletten, Geirr (Copenhagen Univ. (Denmark)). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

A vacuum evaporation technique for deposition of radiation target materials on selected metallic substrates is described. Optimum substrate-target combinations are discussed for Ra, U, Np, Am, La, and Pu targets. (J.R.D.)

59639 (CONF-711002–, pp 134-43) SPECIAL TECHNIQUES IN TARGET PREPARATION FOR CHALK RIVER NUCLEAR PHYSICS EXPERIMENTS. Gallant, J. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Techniques for preparation of very thin films are described along with methods of preparing flat surface foils. Methods are also described for preparation of ^{1}H, ^{2}H, and ^{3}H targets, fabrication of ^{14}C targets, and preparation of films used to determine the energy loss of heavy ions in solids. (J.R.D.)

59640 (CONF-711002–, pp 272-82) ASSAY OF SAMPLES FOR NUCLEAR MEASUREMENTS BY PHYSICAL METHODS. Moret, H.; Verheyen, F. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Of the physical methods of assay, vacuum weighing appears to be the best method to obtain accurate definition of the total mass of foils and deposited layers. However, chemical and isotopic analysis is needed to arrive at the quantity to be measured, i.e., the number of atoms of a specific isotope. Vacuum weighing is a

XUM

complicated operation needing accurate definition of the environment (ultrahigh vacuum) and careful study of all parameters which might affect the mass measurements or have an influence on their interpretation. Other methods described have respective inherent advantages, such as selectivity (x-ray fluorescence), point-to-point measurement (alpha-absorption, electron-probe, densitometry, interferometry, stylus), speed of operation (in particular stylus), and inexpensive equipment (alpha-absorption, interferometry, weighing in air). They all require, however, calibration or reference samples. Interferometry and stylus techniques need calibration since the density of the sample must be measured. Reference samples can be provided through standardization by chemical methods, counting, and evaporation and weighing in vacuum. Major effort is required to arrive at a satisfactory coverage for all samples considering variations in thickness and in the variety of materials of layers and backings required by researchers. For the methods discussed, however, such a study would open the way to superior sample definition. (auth)

59641 (LA-4753) MEDIUM-ENERGY PHYSICS PROGRAM. Quarterly Status Report for the Period Ending July 31, 1971. Dunn, Eleanor D. (comp.) (Los Alamos Scientific Lab., N. Mex.). Sep 1971. Contract W-7405-eng-36. 62p. Dep. NTIS.

The summary of research covers the accelerator structures, the RF power systems, accelerator control and instrumentation, accelerator physics, the experimental area, LAMPF scheduling and facility construction, physics research, and LAMPF users group. A list of research proposals is included. (J.F.P.)

59642 (LA-DC-12795) NUCLEAR CHEMISTRY PROGRAM FOR THE LOS ALAMOS MESON PHYSICS FACILITY. Dropesky, B. J. (Los Alamos Scientific Lab., N. Mex.). [1971]. 4p. (CONF-710911-4). Dep. NTIS.

From fourth international conference on high energy physics and nuclear structure; Dubna, USSR (7 Sep 1971).

In the program outlined the high-intensity pion beams will be used for nuclear chemical investigations of the mechanisms of reactions with complex nuclei, including spallation, fission, fragmentation, and charge-exchange. Also studied will be the interactions induced in complex nuclei by the capture of negative muons. The nuclear spectroscopy of new or little-studied nuclear species produced by proton spallation will be studied to increase understanding of the nuclear structure and mass surface. (J.F.P.)

59643 (ORNL-TM-3523) FAILURE OF ALUMINUM TUBING IN THE ORNL 86-INCH CYCLOTRON. King, R. T.; Long, E. L. Jr. Skidmore, M. R.; Beaver, J. E. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 17p. Dep. NTIS.

A metallographic study of an internally pressurized 1100 aluminum water coolant tube of the ORNL 86-in. cyclotron beam extraction system which fails periodically as a result of 22.5 MeV proton bombardment is described. The ion bombardment creates displacement damage and deposits hydrogen gas which forms bubbles in the tube wall. Accelerated erosion of the tube and failure occur in the region where the bubbles are observed. (auth)

59644 (RHEL/R-222) INTERNATIONAL SURVEY OF THE OPERATION OF DC ELECTROSTATIC PARTICLE SEPARATORS. Davies, K. H. (Rutherford High Energy Lab., Chilton (England)). Jan 1971. 19p. Dep. NTIS (U. S. Sales Only). UK 25p.

During a recent tour of accelerator laboratories in the USA the opportunity was taken to find out the operating techniques in use at Brookhaven, Argonne, and Berkeley, to compare them with those in use at the Rutherford Laboratory. A visit was also made to CERN to establish the techniques in use there. A questionnaire was prepared and this was completed by discussion at each of the laboratories visited. (auth)

59645 (SLAC-Trans-134) BEAM EXPANSION AND INCREASE OF THE AMMAN-RITSON LUMINOSITY LIMIT BY COUPLING AND UNDAMPING OF BETATRON OSCILLATIONS. Ripken, G. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Translated for Stanford Linear Accelerator Center, Calif., from report DESY-H-5-70/7. 57p. Dep. NTIS.

A method for expanding the beam cross section in a storage ring by coupling the betatron oscillations and damping the synchrotron oscillations is described. (auth)

59646 ARRANGEMENT FOR INVESTIGATION OF DIRECT NUCLEAR REACTIONS PRODUCED BY ELECTRONS AND GAMMA QUANTA WITH ENERGIES UP TO 300 MeV. Egiyan, K. Sh.; Bochek, G. L.; Grishaev, I. A.; (and others) (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 5: 381-91(1970). (In Russian).

The description and experimental characteristics of the arrangement designed for investigation of direct nuclear reactions produced by electrons and γ quanta with energies up to 300 MeV on the 300-MeV kharkov linear accelerator are given. The peculiarities of the arrangement due to the pulsed operation of the electron linear accelerator are pointed out. (auth)

59647 MODIFIED SCALAR POTENTIAL IN BOUNDARY-VALUE PROBLEMS IN MAGNETOSTATICS. Doinikov, N. I.; Simakov, A. S. Sov. Phys.-Tech. Phys. (Engl. Transl.); 16: No. 4, 658-60(Oct 1971).

Translated from Zh. Tekh. Fiz.; 41: No. 4, 835-8(Apr 1971).

A modified scalar potential is constructed in three-dimensional form for isotopic media and it is used to formulate a number of interesting practical boundary value problems; methods of solution are indicated. (M.O.W.)

59648 TRANSFORMER FOR ACCELERATOR TUBE. Lisin, V. N.; Kiselev, O. A.; Shtuchkin, N. N. Russian Patent 270,914. 12 May 1970. Filed 2 Jun 1969. (In Russian).

The transformer is composed of a sectional magnetic channel in a tank of oil. Toroidal cores are formed each having a winding and an accelerator tube with a cathode and a grounded anode. Schematic diagrams are included. (J.F.P.)

59649 DEVICE FOR CONNECTING THE GENERATOR TUBE WITH THE RESONANCE SYSTEM OF A SYNCHROCYCLOTRON. Abrosimov, N. K.; Dmitriev, S. P.; Kulikov, A. V.; (and others) (to Physical-Technical Inst.). Russian Patent 270,131. 8 May 1970. Filed 28 May 1969. (In Russian).

The device described is composed of waveguide feeders for which means are given to increase the reliability of excitation in the resonance system and to dampen the transverse oscillations on the electrode. A diagram is shown. (J.F.P.)

59650 PARTICLE ACCELERATORS. Bird, J. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aust. Phys.; 133-7(Sep 1971).

A brief review of developments in the field of particle accelerators is presented, primarily with respect to funding, techniques and applications. The trend of pulsed neutron beam use in nuclear energy developments is summarized. It is noted that greater accuracy in parameters for fast reactor problems is required. Online computers in conjunction with the new generation accelerators are producing improved data in the neutron energy region, and effective international methods for distribution of cross-section data have been augmented. (Australia)

59651 STUDY OF A SYSTEM OF FORMATION OF THE BRAKING RADIATION BEAM OF A MEDICAL BETATRON OF B5M-25 TYPE. Kozlov, A. P.; Bazhanov, E. B.; Dimov, V. I.; Ershov, A. T.; Terpugov, V. G. (Research Inst. of Oncology, Leningrad). Vop. Onkol.; 17: No. 6, 48-53(1971). (In Russian).

The basic characteristics of a system for formation of the bremsstrahlung beam of a new medical betatron of the B5M-25 type with a nominal energy of 25 MeV are studied. It is demonstrated that a dosimeter DIM-60 could be practically used as a monitor of the high-energy bremsstrahlung. (auth)

59652 STOCHASTICITY IN MANY DIMENSIONAL NONLINEAR OSCILLATING SYSTEMS. Chirikov, B.V. (Inst. of Nuclear Physics, Novosibirsk, USSR); Keil, E.; Sessler, A. M. J. Statist. Phys.; 3: No. 3, 307-21(Autumn 1971).

Mathematical models which replicate the essential elements determining the dynamical behavior of particle motion in a storage ring are studied. Qualitative analytic estimates of the stochasticity limit of one- and many-dimensional nonlinear oscillating systems are derived using the overlapping of first-order resonances as a criterion for stochasticity. Computational results obtained with several very simple transformations are compared with the analytic estimates. Numerical studies significantly below the stochasticity limit of a many-dimensional nonlinear system reveal an example of a very slow instability, the first, to be the best of our knowledge. (auth)

59653 ENERGY CONTROL AND MONITORING SYSTEM FOR A TANDEM VAN DE GRAAFF. Brookshier, W. K.; Wallace, J. R.; Langsdorf, A. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 101-9 (Apr 1971).

A system that makes use of the conventional means of controlling the terminal voltage of an electrostatic accelerator (FN Tandem) by shunt current from corona points is described. The voltage is sensed with a beam-deflector system or a generating-voltmeter signal, or a combination of the two methods. The electronic design

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differs considerably from previous designs, the emphasis being placed upon functional simplicity, reliability, and ease of operation. The performance results are indicative of the use of SF_6 as a filling gas. (auth)

59654 CAMAC SYSTEMS AT LAMPF. Machen, D. R.; Biswell, L. R. (Los Alamos Scientific Lab., N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 63-4(Apr 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The computer-based data system to be installed at LAMPF and the use of CAMAC for interfacing are briefly described. (R.W.R.)

59655 NAL CAMAC ACCELERATOR CONTROL. Klaisner, L. A. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 61-2 (Apr 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The control system for the National Accelerator Laboratory's Booster Synchrotron is compatible with the CAMAC standard; this use represents the first application of this standard to a large process control system. Parts of the system are installed and have operated successfully. (auth)

59656 PROPORTIONAL WIRE CHAMBER ELECTRONICS SYSTEM UTILIZING CAMAC. Bertolucci, B.; Carman, R.; Faust, J.; Horelick, D.; Pellegrin, J.-L. (Stanford Univ., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 53-60(Apr 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A system of electronics to be used with a proportional-wire-chamber hodoscope is described. The system, which uses CAMAC packaging and data-handling philosophy, consists of octo (8-channel) wire signal amplifiers, octo 4-bit per wire latch modules, gate fanout modules, crate controllers, and two types of data processor-interface units to the SDS 9300 computer. System operation is explained, and each component is described. (auth)

59657 ACTIVATION OF THE CONCRETE SHIELD OF THE OIYaI SYNCHROCYCLOTRON BY SCATTERED RADIATION. Zaitsev, L. N.; Kimel, L. R.; Sidorin, V. P. This paper was summarized in At. Energ. (USSR); 29: No. 5, 368-9(Nov 1970) as paper No. 445/5853. (In Russian).

Full copy of this paper is held by DTIE.

Analysis shows that the greatest hazard from radioactivation of the concrete shielding at the JINR synchrocyclotron is presented by the formation of the radioactive ^{24}Na (half-life, 15 h) and ^{56}Mn (half-life, 2.6 h) nuclei, which are generated as a result of neutron capture by the ^{23}Na and ^{55}Mn nuclei in concrete. Specimens of the concrete used for experimental investigations were irradiated for about 130 h in the "hard" spectrum of scattered radiation of the JINR synchrocyclotron. The induced activity spectra were measured by means of a γ-spectrometer with a 38 × 30 mm NaI(Tl) crystal. Two total-absorption peaks with energies of 1.37 and 2.75 MeV from ^{24}Na, and a 0.845 MeV peak from ^{56}Mn can be separated in these spectra. In order to determine the effect of boron-containing additions on the degree of shield activation, the dose rate was measured at the surface of blocks made of ordinary and boron-containing concrete (boron content, 15 kg/m^3). The measurements were performed by means of a portable scintillation γ-radiometer. (W.H.K.)

59658 YALE–NAL CAMAC SYSTEM. Dhawan, Satish (Yale Univ., New Haven). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 2, 65-7(Apr 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A data acquisition system for high-energy physics experiments is described; it is in accordance with the specifications of EUR 4100e and EUR 4600e. This is a multicrate system using branch highway and type A crate controllers. Most of the components are commercially available. (auth)

59659 CROSSED-FIELD ELECTRON INJECTOR FOR AN ELECTRON ACCELERATOR. Hogg, Harold A. (to United States Atomic Energy Commission). U. S. Patent 3,593,058. 13 Jul 1971. Filed 17 Mar 1970.

An electron injector wherein a stream of electrons is emitted from a gridded thermionic emitter into a region between two electrodes is described. An electric field alternating at a microwave frequency is applied between the electrodes, and the electron stream leaves the thermionic emitter parallel to this field. A steady magnetic field is applied across the region in a direction that is transverse to the electric field. The combined effects of the microwave electric field and the steady magnetic field on the electron stream are such that the stream becomes focused into a bunch that follows a quasi-cycloidal orbit in which the electrons strike a secondary emitter from which an amplified bunch of electrons is emitted to follow a similar orbit, to be further focused into a bunch and to strike another secondary emitter. This process is repeated until the desired intensity is achieved whereupon the final bunch of electrons is injected into an electron accelerator during the final orbit. (auth)

59660 VALVE AND PULSE-WIDTH-MODULATED DATA LINK USING INFRARED LIGHT TO CONTROL AND MONITOR POWER SUPPLY FOR MODULATOR FOR HIGH-ENERGY LINEAR ACCELERATOR. Witkover, Richard L. (to United States Atomic Energy Commission). U. S. Patent 3,590,250. 29 Jun 1971. Filed 6 Jun 1969.

A method and apparatus for transmitting information across a high-voltage interface by light pulse-width modulation for remotely monitoring, controlling and/or energizing high-voltage apparatus are described. (auth)

59661 PERFORMANCE OF CLINICAL LINEAR ACCELERATOR. Fujita, Hyota; Suzuki, Toshimitsu; Uetomi, Isamu; Machida, Kenji; Kanzawa, Hiroshi (Mitsubishi Electric Corp., Amagasaki, Japan). Mitsubishi Denki Giho: 45: No. 5, 660-72(May 1971). (In Japanese).

The ML-15 M II Linac put on the market recently has an electron beam energy of 15 MeV and is capable of being used for electron beam treatment as well as X-ray treatment, thus the scope of application is being enlarged a great deal. A magnetron is usually used for a high frequency source, but the new apparatus is provided with a Mitsubishi klystron PV-2012 W so as to facilitate multi-step changeover of energy. In addition, the output dose has been stabilized. (auth) (Japan)

59662 NEW POWER SUPPLY EQUIPMENT IN THE IMPROVEMENT PROGRAM FOR THE 28-GeV CERN PROTON SYNCHROTRON AT GENEVA. Stirba, Alois; Vau, Guenter (Siemens Aktiengesellschaft, Erlangen, Ger.). Siemens Rev.: 38: No. 6, 243-7(Jun 1971).

In the course of a recent extension program a number of new power supplies became necessary for the 28-GeV proton synchrotron which has been in operation since 1959. A brief description of the mode of operation of the proton synchrotron is followed by an account of the many severe requirements to be met by such power supplies, taking as an example the pulse power supply for the ring magnets. (auth)

59663 NEW POWER SUPPLY SYSTEM FOR THE MAIN RING MAGNETS OF THE 28-GeV CERN PROTON SYNCHROTRON AT GENEVA. Vau, Guenter (Siemens Aktiengesellschaft, Erlangen, Ger.). Siemens Rev.: 38: No. 6, 247-53(Jun 1971).

The technical solution chosen for the pulsed power supply to the ring magnets of the 28-GeV proton synchrotron which has a peak power of 95 MVA is described. The mode of operation and the main technical specifications are described, emphasis being laid on the developments and special technical designs involved. An account is also given of the experience gained in two years of pulse duty with more than 23 million pulses. (auth)

59664 ACCELERATOR INSTRUMENTATION AND CONTROL SYSTEM USING CAMAC. Klaisner, L. A.; Stephenson, J. M. Jr. (National Accelerator Lab., Batavia, Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 299-301(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The 8-GeV Booster Synchrotron, presently under construction at the National Accelerator Laboratory, is controlled by a computer-based system, which has been implemented using the CAMAC Standard for data handling systems. The design philosophy and the hardware for the control system are described. (auth)

59665 PROGRAMMABLE DATA ACQUISITION INTERFACE. Hamilton, C. C.; Hiebert, J. C.; Rogers, R. C. (Texas A and M Univ., College Station). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 302-6(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

An on-line system for data acquisition and analysis was recently placed in operation to support the research programs at the Texas A&M University Variable Energy Cyclotron facility. The system consists of an IBM 7094 computer and a programmable experiment–computer interface unit. The interface is a logical extension of the computer system, which ensures hardware and software compatibility. (auth)

59666 USE OF A TIME-SHARED, ON-LINE COMPUTER TO SUPPORT BASIC AND APPLIED RADIATION RESEARCH. Powell, J. E.; Phillips, A. R.; Kefauver, H. L. (Sandia Labs., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 307-11(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The Sandia Data Acquisition and Display System (DADS) is being used in a time-shared, real-time mode to support basic and applied radiation research. Five remote terminals provide computer access for experiments such as electron beam diagnostics, fast neutron spectrum measurements, static and dynamic reactor fuels testing, and neutron-damage studies on solid-state electronic components. The system has substantially increased radiation facility and experimenter efficiency. A description of the DADS is given, and its utility is demonstrated by discussing some of the experiments that are currently interfaced to the system. (auth)

59667 USE OF ARRAYS SMALLER THAN IMPLIED BY THE RANGE OF DESCRIPTORS FOR MULTIPARAMETER PULSE HEIGHT ANALYSIS. Hensley, D. C.; Goodman, C. D. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 312-16(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A program for use with multiparameter pulse height analysis is described. The main purpose of the program is to permit reasonably rapid accumulation of data into arrays that are much smaller than implied by the range of descriptors. In addition, the method readily permits the use of descriptors that exceed the bit capacity of the computer word. Any grouping of zero and nonzero channels, as is observed in most real spectra, is especially exploited. In many cases, the data can be retained in a packed array in core memory until the actual number of nonzero channels becomes almost as large as the allotted core-memory space, at which time the array is transferred to another space in core (where it will be transferred onto disc as a background operation), the core array is reinitialized, and the data acquisition is continued. With this procedure, multichannel arrays as large as the available disc memory can be stored on disc without the data acquisition suffering from the very slow random access time of the disc. Methods of data handling and the resulting effective counting rates are discussed. (auth)

59668 SYSTEM FOR MULTIPARAMETER PULSE HEIGHT ANALYSIS WITH REPEATED USE OF A SINGLE, FAST ADC. Goodman, C. D. (Oak Ridge National Lab., Tenn.); Ludemann, C. A.; Hensley, D. C.; Kurz, R.; Anderson, E. W. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 323-6 (Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

In many nuclear physics experiments an event consists of correlated output pulses from several radiation detectors. Each separate output pulse is called a parameter; multiparameter experiments are considered. A system in which a single ADC is interfaced to a general purpose computer is discussed. Multiparameter experiments are handled by storing the several pulses in analog stretchers and using the ADC repeatedly to digitize the several pulses in sequence. This approach is made practical by the availability of a very fast ADC. The system includes features that give it unusual flexibility for handling complicated time relationships among the pulses. The use of one rather than several ADC's makes the system simpler, more compact, and less expensive than multiple-ADC systems. Provisions are included for evaluating counting loss due to dead time of the system for random or nonrandom event distributions. The data transfer logic incorporates the facility for including digital information from devices in addition to the ADC in each event datum. (auth)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 58384 and 60210.

59669 (CEA-R-4172) DEVELOPMENT OF ^{242}Cm–Be AND ^{238}Pu–Be NEUTRON SOURCES. Brachet, Guy; Vasseur, Claude (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Apr 1971. 11p. (In French). Dep. NTIS (U. S. Sales Only).

The preparation of ^{242}Cm–Be and ^{238}Pu–Be neutron sources is described. (R.W.R.)

59670 (CONF-711002–, pp 166-80) TRITIUM-CONTAINING TARGETS FOR HIGH-YIELD NEUTRON GENERATORS. O'Donnell, F. R.; Adair, H. L. (Oak Ridge National Lab., Tenn.). Oct 1971.

From third international symposium on research materials for nuclear measurements; Gatlinburg, Tenn. (5 Oct 1971).

Large-area erbium tritide targets have been fabricated and used for producing intense neutron fields. Neutron yields were generally in the expected range with most targets producing maximum yields to $>10^{13}$ n/sec. Target life was less than desired, but long enough for the user to perform the desired experiments. One titanium tritide target was prepared and found superior to all the erbium tritide targets tested. Fabrication parameters and equipment design are described, but no correlation was found between fabrication parameters and the operational performance of the targets. Tritium sorption was best started at temperatures in excess of 400°C and pressures in excess of 300 torr. Once the problem of substrate surface contamination was solved, successful targets were routinely fabricated. Radiation levels in excess of 10 R/hr at the target surface were used as an indication of acceptable target preparation. Small, laboratory scale targets fabricated simultaneously with the large HENRE targets were used to give an indication of the large target's performance. (auth)

59671 (IFA-DNBR-3) PROGRAM FOR THE COMPUTING OF THE SCATTERING CROSS-SECTIONS IN HEAVY WATER. Gheorghe, D.; Rapeanu, S.; Stefan, H. (Institutul de Fizica Atomica, Bucharest (Romania)). 1971. 21p. Dep. NTIS (U. S. Sales Only).

The RIVA code is given for the double differential scattering cross sections for neutron scattering by heavy water, the scattering matrix, and the integrated cross section for various temperatures. (J.F.P.)

59672 (KFKI-71-45) CORRELATION TECHNIQUE AT PULSED NEUTRON SOURCES. Kroo, N.; Pellionisz, P. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1970]. 14p. Dep. NTIS (U. S. Sales Only).

It is shown that the correlation technique can be applied at pulsed reactors so that white ingoing neutron beams can be used and the whole two-dimensional scattering spectrum can be evaluated by data processing by correlation. The principles of the method and a simple error analysis are given. (auth)

59673 (LFEN-NI.-51-a) INTRODUCTION TO THE STUDY OF THE PROBLEM OF SCATTERING OF SLOW NEUTRONS BY CONDENSED MATTER. Carvalho, Frederico Gama (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1969. 29p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

The general equations of transport and scattering are presented. The equations for scattering by a free nucleon and the integral equation for scattering by a particle system are derived. The effective cross section $\sigma(E_0 \to E, \vec{k}_0 \to \vec{k})$ is considered. (J.S.R.)

59674 SPECTRA OF FAST NEUTRONS FROM WATER PULSED WITH 14-MeV NEUTRONS. Stelts, Marion L.; Anderson, John D.; Hansen, Luisa F.; Plechaty, Ernest F.; Wong, Calvin (Univ. of California, Livermore). Nucl. Sci. Eng.; 46: No. 1, 53-60(Oct 1971).

The validity of the neutron Monte Carlo transport code, SORS, was established for the transport of fast neutrons through water by comparing the measured time spectra of neutrons from spherical water targets of 1.0 and 1.8 mean-free-paths radii with the calculations. The energy degradation and spatial spreading of a beam of 14-MeV neutrons through a thickness of water comparable to the thickness of a human body were calculated for use in the design of experiments to treat cancer tumors with 14-MeV neutron beams. For use in shielding applications, further calculations have also been made of the transport of neutrons from an isotropic source of 14-MeV neutrons located at the center of spherical water shields having radii from 0.5 to 7.0 mfp. (auth)

59675 DISCRETE SN NUMERICAL METHOD IN NEUTRON TRANSPORT THEORY. Pavelescu, M. (Inst. of Atomic Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 3, 327-51(1971). (In Rumanian).

The multigroup approach to the Boltzmann Equation is used for solving the neutron transport problem: difference equations and the discrete SN method are presented. The discrete SN (DSN) equations are then studied: integration on the space variable, fundamental assumptions in the DSN approximation, and comparison between DSNG and SNG are included. The solution of the difference equations is then taken up. After the boundary conditions and an outline of the numerical procedure are given, inner iteration, source calculation, and outer iteration are discussed. (R.W.R.)

59676 INSTALLATION OF THE NEUTRON-GENERATOR NA-2 IN THE NUCLEAR RESEARCH INSTITUTE OF CZECHOSLOVAK ACADEMY OF SCIENCES. Tomaskova, Lenka; Hendlinger, Evzen (Radiologicka Dozimetrie UJV CSAV, Prague). Radioisotopy; 11: No. 5, 787-93(1970). (In Czech).

In the Nuclear Research Institute of Czechoslovak Academy of Sciences the installation of the Hungarian 14-MeV neutron-generator was accomplished. The main characteristics of the generator, shielding, and possibilities of its application are described. (auth)

59677 USE OF VARIATIONAL VARIABLE BOUNDARY FUNCTIONALS FOR CONSTRUCTING APPROXIMATION METHODS FOR NEUTRON TRANSPORT THEORY. Slesarev, I. S.; Sirotkin, A. M. Zh. Vychisl. Mat. i Mat. Fiz.; 11: No. 2, 529-34(Mar-Apr 1971). (In Russian).

The variational approach to the construction of a finite-difference solution to the neutron transport equation is investigated. This was aided by the formulation of a series of algorithms using the simplest class of trial functions. The variational formulation of the problem furnishes a "criterion of optimization" of the finite-difference network for the purpose of refining the evaluation of the desired neutron field functional. Numerical examples of a solution to the neutron physics problem are worked out. An equation with the essential finite-difference methods is presented. (tr-auth)

59678 EFFECT OF INTERMOLECULAR FORCES ON THE NEUTRON SCATTERING SPECTRUM OF SIMPLE FLUIDS. Cohen, Herschel. Tallahassee; Florida State Univ. (1970). 112p. University Microfilms Order No. 71-18,355.

Thesis.

The theory of thermal neutron scattering is concisely reviewed using both the Born approximation and transition probability to obtain the scattering equations. It is demonstrated that the scattering spectrum of simple fluids is quite generally derived using a linear response formulation of the scattering problem. The unity and enhancement of physical insight gained by such an approach is discussed. The scattering spectrum is identified as the translational fluctuations of the target system at equilibrium. The formal result for the scattering spectrum is investigated for the cases of ideal and real gases at moderate densities to obtain forms amenable to calculation valid in the classical limit. These forms were considered using both unsymmetrized and symmetrized bases and were shown to reduce to the unsymmetrized result for temperatures and particle masses of interest. Further research based on the technique employed or extensions thereof are discussed. (Diss. Abstr. Int., B)

59679 PROPAGATION OF SOUND WAVES AND NEUTRON WAVES IN BOUNDED PLANE GEOMETRY. Cassell, J. S.; Williams, M. M. R. (London Univ.). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 987-1006(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

Integral equations are formulated for neutron-wave propagation parallel to the faces of a slab and sound wave propagation in a gas confined between parallel plates. The main physical differences arise from the different conditions satisfied by the particle distribution functions at the boundaries of the systems, i.e., neutrons can pass through a boundary unhindered while gas atoms are reflected from it. By specializing to simple diffuse reflection for gas atoms and using very crude separable kernel scattering models, it was possible to obtain by the methods of generalized analytic functions approximate expressions for the discrete eigenvalues, i.e., the propagating modes. These eigenvalues are shown to depend upon the frequency of the wave and the transverse dimensions of the system. However, because of the boundary conditions, results for neutrons and gas atoms show some interesting differences. (auth)

59680 METHOD FOR COMBINING THE LOWER- AND HIGHER-ORDER DISCRETE-ORDINATE APPROXIMATION TO THE TRANSPORT EQUATION. Takahashi, Hiroshi (Brookhaven National Lab., Upton, N. Y.). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 963-72(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

A method for combining lower order, S_n, and higher order, S_N, discrete ordinate approximations that apply to the regions in which the fluxes are weakly anisotropic and strongly anisotropic is studied. These are combined by calculating the anisotropic flux in one region from the fluxes in the other region. This is done for positive and negative directional cosine using interpolation and extrapolation methods. A sample calculation using the one-dimensional UO_2-H_2O core and control slab lattice is performed. The results indicate that this method works well provided the interpolated and extrapolated fluxes are accurate. The extension of this method to multi-dimensional geometry is also discussed and it is shown that there is no difficulty in principle. (auth) (UK)

59681 DIFFRACTION POLARIZATION OF NEUTRONS IN A POLARIZED CRYSTAL. Korennaya, L. N. (Belorussian State Univ., Minsk). Sov. Phys.-Solid State (Engl. Transl.); 13: No. 3, 727-30(Sep 1971).

Translated from Fiz. Tverd. Tela; 13: No. 3, 880-4(Mar 1971).

The propagation of a coherent neutron wave through a magnetized specimen with polarized nuclei is examined. It turns out that the refractive index of the neutrons in the magnetized target is determined by the mean magnetic field produced by the electrons in the target. The diffraction polarization of neutrons is examined. It is shown that the wavelength change of the radiation in the medium enables polarization of an initially unpolarized neutron beam by purely magnetic scattering. (auth)

59682 SOME ANALYTICAL METHODS IN NEUTRON TRANSPORT THEORY. Corngold, Noel (California Inst. of Tech., Pasadena). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 851-68(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

Some distinctive features of neutron transport theory are discussed. The linearized transport equation is similar to those met in theories of gas dynamics and radiative transfer. The analytical techniques that have been most successful in analyzing the neutron equation are described. Among these are the method of separated solutions (in space and angle coordinates), and the construction of velocity-dependent collision models. (auth) (UK)

59683 FUNDAMENTAL EIGENVALUES OF THE LINEAR TRANSPORT EQUATION. Mika, Janusz (Inst. of Nuclear Research, Otwock, Poland). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 879-91(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

In neutronic applications of the linear transport theory, an important role is played by two parameters characterizing a given reactor system. The fundamental time constant α, which is an eigenvalue of the transport operator with the largest real part, and the constant γ which is the number with the largest absolute value such that if the fission neutron source in the transport equation is multiplied by $1/\gamma$ then the equation has a solution. It follows from the physical reasons that both α and γ should be real and the corresponding eigenfunctions nonnegative. This fact has also been confirmed theoretically in many important cases. An auxiliary eigenvalue problem for the neutron transport equation is considered leading to a convenient method of calculating the constants α and γ and the corresponding eigenfunctions. The properties of the fundamental solution to the auxiliary eigenvalue problem are shown to be such that the proposed calculational method is well convergent. (auth) (UK)

59684 NUMERICAL METHODS APPLIED TO PROBLEMS OF NEUTRON TRANSPORT. Askew, J. R. (Atomic Energy Establishment, Winfrith, Eng.). J. Quant. Spectrosc. Radiative Transfer; 11: No. 6, 905-19(Jun 1971).

From Symposium on the application of transport theory; Oxford, England (1 Sep 1970).

Numerical methods applied to problems of neutron transport are reviewed, with emphasis upon those less widely used in other fields. The treatment of the energy variable is discussed followed by collision probability, discrete ordinate and Monte Carlo methods. An attempt is made to identify possible improvements to existing approximations. (auth) (UK)

59685 TEMPERATURE DEPENDENCE OF NEUTRON INELASTIC SCATTERING FROM WATER. Esch, Louis James. Troy, N. Y.; Rensselaer Polytechnic Inst. (1971). 235p. University Microfilms Order No. 71-19,879.

Thesis.

The neutron inelastic scattering properties of water were measured at temperatures of 27 C, 170 C, and 270 C by using neutrons with incident energies ranging from 0.04 eV to 0.632 eV at scattering angles of 10, 14, 25, 40, 60, 90, 120, and 150 degrees. A pulsed source of partially thermalized neutrons was provided by the RPI Linear Electron Accelerator (LINAC), an electron-to-neutron converter, and a thin moderator. The LINAC was phased with a high-speed neutron chopper to select the desired neutron-energy from the moderator leakage spectrum. The incident and scattered neutron energies were determined by time-of-flight techniques, including multichannel analyzers and an on-line computer. The scattered neutron time-of-flight distribution was converted to the double differential scattering cross section, $d^2\sigma/dEd\Omega$, by using other measured integral values of angular distribution and total cross section for water as an internal normalization. The scattering law $S(\alpha,\beta)$ was also derived from the data. The experimental resolution function was measured. The conditions of experimental resolution thus determined, as well as the conditions of multiple scattering and absorption in the sample, were imposed on various theoretical models by means of a Monte Carlo computer program. The adjusted models were compared with data. Comparisons of these results with various theoretical models indicate that the best model is one developed here in which the water scattering system is considered as consisting of aggregates of icelike structures with temperature dependent sizes, diffusing with a temperature-dependent diffusion constant. The energy levels of the molecules bound in the clusters are represented by a multi-Gaussian frequency distribution that varies with temperature. The internal vibrations of the individual water molecules are represented by delta functions. (Diss. Abstr. Int., B)

59686 THERMAL NEUTRONS. DISTRIBUTION OF LIFETIMES. Goded, F. (Escuela Tecnica Superior de Ingenieros Industriales, Madrid). Nuovo Cim., 4B: No. 1, 73-87(11 Jul 1971).

To distinguish between neutrons of the same energy a convenient property to use should be their chronological age T measured from the moment the neutron enters into a given system. A method to derive the neutrons' density N(r,T) when dealing with the thermal group is presented. This method is later applied to the problem of a nonmultiplicative infinite homogeneous medium where there is a planar source of thermal neutrons of constant strength S neutrons/$cm^2 \cdot s$ at $x = 0$. The neutron density N(x,T) as well as the total density $n_\beta(T) = \int_0^\infty N(x,T)dx = (S/2v) \exp[-\Sigma_a vT]$ are found. Using a simple model it is proved that the total density $n_\beta(T)$ already obtained is the correct one. Later the solution N(x,T) is derived again using an entirely different approach which provides a better insight into the problem. The neutron density N(x,T) as well as the total density $n_\beta(T)$ for the specific cases of light and heavy water are briefly described and the corresponding curves plotted. Although actual reactors, i.e. multiplicative mediums of finite size are not dealt with, it is clear that these more interesting situations from the practical point of view could be treated by the same method in order to get their neutron densities, N(r,T) and $n_\beta(T)$. (auth)

59687 NOTE ON THE DETERMINATION OF NEUTRON DIFFUSION CONSTANTS. Aleksandrov, L.; Stanolov, A.; Khristov, V. This paper was summarized in At. Energ. (USSR); 29: No. 4, 283-4(Oct 1970) as paper No. 431/5651. (In Russian).

The difficulties associated with the determination of neutron diffusion constants by approximation methods are discussed. A method for the determination of the diffusion constants is proposed and applied to a hydrogen–aluminum lattice. A method for estimating the accuracy of the technique is suggested. (J.W.R.)

59688 REACTOR KINETIC CALIBRATION OF NEUTRON SOURCES AND ITS COMPARISON WITH BATH METHODS. Breitenhuber, L.; Kindl, P. (Institut fuer Kernphysik, Graz, Austria). Atomkernenergie; 18: No. 1, 20-4(Aug 1971).

The neutron source strength (RaD–Be, $5 \cdot 10^4$ n/s) has been obtained from the linear increase of the power of the ARGONAUT reactor utilizing a measurement of the adjoint flux ratio with uranium. The knowledge of resonance absorption and fast leakage (Littler) is circumvented by these concepts. A second reactor method is based on the power at which the source absorption balances the source neutrons. The results agree within 2% with data from a water and boric acid bath measurement. The flux distribution had been obtained by a small BF_3-counter whose absolute calibration was performed by fission track counting in mica and macrofol. A 6-group diffusion calculation is in good agreement with the observed spatial flux dependence. (auth)

59689 RIVA–BUTLER'S CODE. Rapeanu, S.; Gheorghe, D.; Stefan, H. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 5, 587-90(1971).

The Butler model for neutron scattering in heavy water is discussed. The basis of the RIVA code, which makes use of the Butler formalism in the Koppel–Young approximation, is described. The RIVA code calculates the double-differential scattering cross section, the total cross section, and the scattering matrix for thermal energies. (J.W.R.)

59690 STUDY OF FORMATION OF NEUTRON BEAMS FROM ISOTOPE NEUTRON SOURCES. Ponomarev, E. G.; Tyufyakov, N. D.; Shtan, A. S.; Yaskevich, V. S. Tr. Vses. Nauch.-Issled. Inst. Radiats. Tekh.; No. 5, 98-103(1970). (In Russian).

Experimental studies were performed on the influence of individual factors on beam characteristics. The measurements were performed in a water tank (1000 mm diameter, 1200 mm high) with two sources (^{238}Pu + Be and ^{252}Cf) having different fast-neutron energy spectra. In order to reduce the perturbations of the neutron flux, the source and collimator holders were made of organic glass, while the collimators themselves were made of paper soaked in paraffin or of steel pipe with a wall thickness of 0.1 mm. Neutron flux measurements were performed using indium foils as well as a scintillation counter with an LiI (Eu) single crystal enriched to 90% ^{6}Li (crystal diameter 30 mm, thickness 4.4 mm). (JPRS)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 59397, 59506, and 59783.

59691 (LA-DC-12958) DISPERSION RELATIONS FOR NUCLEAR STRUCTURE PHYSICS. Kisslinger, Leonard S. (Carnegie-Mellon Univ., Pittsburgh, Pa. Los Alamos Scientific Lab., N. Mex.). [1971]. 4p. (CONF-710911-5). Dep. NTIS.

From fourth international conference on high energy physics and nuclear structure; Dubna, USSR (7 Sep 1971).

Forward dispersion relations are used to explore the effects of the unphysical cuts and to investigate techniques for including them in neutron–deuteron elastic scattering. Fixed-energy dispersion relations are used in a preliminary survey of the same data to find the spectroscopic factors, making full use of the angular distribution. The purpose of this survey was to gain information about the effects of the cuts and the possibility of taking them into account by a conformal mapping procedure. (J.F.P.)

59692 (ORO-1316-99) NUCLEAR PHYSICS. Progress Report. Phillips, G. C. (Rice Univ., Houston, Tex.). [31 Mar 1971]. Contract AT(40-1)-1316. 13p. Dep. NTIS.

The research summarized covers neutron reactions, multiparticle break-up experiments and few-nucleon problems, polarization studies, and nuclear theory. A list of publications is included. (J.F.P.)

59693 (ORO-1316-100) NUCLEAR STRUCTURE AT INTERMEDIATE ENERGIES. Progress Report. Phillips, G. C. (Rice Univ., Houston, Tex.). [31 Mar 1971]. Contract AT(40-1)-1316. 17p. Dep. NTIS.

The summary of research on nuclear structure at intermediate energies includes proton and π^+ and π^- reactions and nuclear theory. A list of publications is included. (J.F.P.)

59694 CHARGE-EXCHANGE AND/OR KNOCKOUT SPECTATOR POLES IN THE REACTION D(^{3}He,tp)p. Warner, R. E. (Oberlin Coll., Ohio); Ball, G. C.; Davies, W. G.; Ferguson, A. J.; Forster, J. S. Phys. Rev. Lett.; 27: No. 14, 961-4(4 Oct 1971).

Intense spectator-proton peaks were observed in the reaction D(^{3}He,tp)p. Their shapes were well fitted by plane-wave Born-approximation calculations, assuming either knockout or ^{3}He–n quasi-elastic scattering accompanied by charge exchange to be the mechanism. Their intensities relative to the quasi-elastic peaks from D(^{3}He,^{3}Hep)n were correctly predicted by charge-exchange calculations, but only when an unrealistic mixture of exchange forces was used. All direct knockout calculations gave relative intensities at least ten times too small. (auth)

59695 POLARIZATION TRANSFER IN THE REACTION T(p,n)^{3}He AT 0° FOR E_p IN THE RANGE 3 TO 16 MeV. Donoghue, T. R.; Haight, R. C.; Lawrence, G. P.; (and others) (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 27: No. 14, 947-9 (4 Oct 1971).

The polarization of the neutrons was measured for the reaction T(p,n)^{3}He at 0° for conditions where the incident beam is transversely polarized. The neutrons were observed to be highly polarized in the same direction as the incident proton spin, with values of the polarization transfer coefficient $K_y^y(0°)$ ranging from +0.39 to +0.83. R-matrix calculations using published ^{4}He level parameters of Werntz and Meyerhof [Nucl. Phys., A121: 38(1968)] do not agree well with these measurements. (auth)

59696 NEUTRON–PROTON AND NEUTRON–CARBON SCATTERING AMPLITUDES. Koester, L.; Nistler, W. (Technische Univ., Munich). Phys. Rev. Lett.; 27: No. 14, 956-8(4 Oct 1971).

Measurements of the n–p and n–C coherent atomic scattering amplitudes are described. The results, $\alpha_H = -3.740 \pm 0.003$ fm and $\alpha_C = 6.6648 \pm 0.003$ fm, were obtained by reflection measurements on seventeen various liquid mirrors with the neutron gravity refractometer, for which a more accurate method of evaluation is given. The mirrors were composed of the elements hydrogen, carbon, and chlorine. The atomic scattering amplitude of chlorine was found to be $\alpha_{Cl} = 9.580 \pm 0.002$ fm. The new α_H is of importance for describing the n–p system. (auth)

59697 IZOTOPY. III. BIBLIOGRAFIYA SPRAVOCHNYE TABLITSY. (Isotopes. III. Bibliographies and Reference Tables). Selinov, I. P. Moscow; Izdatel'stvo Nauka (1970). 256p.

Over 10,000 references are tabulated in this volume, pertaining to the stable and radioactive isotope data of the first two volumes (NSA 25: 20264), the references are grouped according to the year of publication from 1896 to 1969. Substantial appendices contain a chart of the Periodic System and Atomic Nuclei and tables of atomic masses (29 pp, to ^{257}Fm), the elementary particles, and fundamental physical constants. (K.S.W.)

59698 DISPERSIVE APPROACH TO THE ^{4}He(γ,d)d REACTION. Erdas, F. (Univ., Cagliari, Italy); Pompei, A.; Quarati, P.; Mosconi, B. Nucl. Phys.; A174: No. 3, 657-67(1971).

The dispersive approach is applied to the reaction ^{4}He(γ,d)d. The transition matrix element, which includes final-state interactions, is deduced as a solution of the Omnes–Muskhelishvili integral equation. The d–d phase shift used contains a resonance due to a supposed 2^+, T = 0 state in ^{4}He at about 33 MeV excitation energy. The cross section calculated reproduces quite well the experimental results in the interval 0 to 10 MeV relative energy of the final deuterons; this result confirms the existence of the supposed state in ^{4}He. (auth)

59699 COINCIDENCE STUDY OF THE REACTION ^{2}H(d,dp)n. Corey, B. E. (Oberlin Coll., Ohio); Warner, R. E.; Bercaw, R. W. Nucl. Phys.; A174: No. 3, 468-84(1971).

Absolute coincidence cross sections were measured for the reaction ^{2}H(d,dp)n at E_d = 20.7 MeV. Strong peaks were observed centered at the minimum neutron laboratory energies. Their shapes were well fitted by PWBA calculations using both zero- and finite-range transition potentials, and by the PWBA modified by including the final p–n interaction. These calculations suggested the importance of both the simple spectator process and more complex mechanisms. DWBA calculations gave poorer fits. No conclusive evidence for unbound ^{3}He levels was obtained. (auth)

59700 VECTOR AND TENSOR ANALYSING POWERS OF THE D(d,p)T AND D(d,n)^{3}He REACTIONS AT 10.0 AND 11.5 MeV. Grueebler, W.; Koenig, V.; White, R. E.; (and others) (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett.; 36B: No. 4, 337-8(20 Sep 1971).

The analyzing powers iT_{11}, T_{20}, T_{21}, T_{22} of the D(d,n)^{3}He reaction between 90° and 160° c.m. are compared with those of the D(d,p)T reaction at 10.0 and 11.5 MeV. Differences are observed for T_{20}, but no differences outside the experimental error exist for iT_{11}, T_{21} or T_{22}. (auth)

59701 CHARGE ASYMMETRIC POTENTIALS AND THE THREE NUCLEON SYSTEM. Okamoto, K.; Pask, C. (Univ. of New South Wales, Kensington, Australia). Phys. Lett.; 36B: No. 4, 317-20(20 Sep 1971).

The effects of charge asymmetric potentials, derived using meson mixings and photon-pion exchange, on the binding energy difference of ^{3}H and ^{3}He and on the n–n and p–p scattering lengths are investigated. (auth)

59702 EFFECTS OF THE NEUTRON PICKUP PROCESS ON ^{3}He(p,pd)p QUASI-FREE SCATTERING. Epstein, M. B.

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(California State Coll., Los Angeles); Slaus, I.; Shannon, D.; (and others). Phys. Lett.; 36B: No. 4, 305-6(20 Sep 1971).

Anomalies in the QFS enhancement in the ^{3}He(p,pd)p reaction have been observed. The effects of the coherent addition of the ^{3}He(p,d)pp $l = 0$ neutron pickup mechanism to the QFS amplitude have been investigated and this calculation qualitatively reproduces the basic features of the data. (auth)

59703 DOUBLE SCATTERING IN THE COMPTON EFFECT BY LIGHT NUCLEI. Alimov, A. D. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 9, 25-6(1970). (In Russian).

The double-scattering contribution was studied in Compton scattering of gamma quanta by a deuteron and a carbon nucleus. Calculation of Glauber's term may give information on the "shadow" effect of scattering on the angular dependence of the cross section, especially at high energies. Nonrelativistic approximations were made in order to avoid cumbersome computations associated with particle spin. The contribution from double scattering for the reaction $\gamma + {}^4\text{He} \rightarrow \gamma + {}^4\text{He}$ lay within the limits 18 to 22%. This suggests that the large number of nucleons increased the "shadowing" effect in scattering. (K.S.W.)

59704 COMPARISON OF THE BRUECKNER AND JASTROW METHODS IN ELECTRON SCATTERING. Ciofi Degli Atti, C. (Istituto Superiore di Sanita, Rome); Kallio, A. Phys. Lett.; 36B: No. 5, 433-6(4 Oct 1971).
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It is shown that Brueckner and Jastrow correlations give very similar results for the charge form factor, density and radius of ^{4}He nucleus. (auth)

59705 T($\vec{\text{d}}$,n)^{4}He REACTION WITH POLARIZED DEUTERONS AT ENERGIES ABOVE THE 107-keV RESONANCE. Grunder, H.; Gleyvod, R.; Lietz, G.; (and others) (Univ., Basel). Helv. Phys. Acta; 44: No. 5, 662-78(15 Aug 1971). (In German).

A source of polarized deuterons, producing a 0.2 μA beam characterized by $P_{33} = .60$ and located on the high potential terminal of a 1-MeV cascade generator, is described. The analysing power of the T(d,n)^{4}He reaction for deuteron tensor and vector polarization at energies of 0.2, 0.6, 0.8 and 1 MeV has been measured. Fits to the data using Legendre polynomials were employed in conjunction with an analysis in terms of the reaction-matrix in order to obtain information about the elements contributing to the reaction. At energies above the 107 keV $\frac{3}{2}^+$-resonance the s-wave element with $J^\pi = \frac{1}{2}^+$ as well as p-wave elements become significant. (auth)

59706 COMPOUND NUCLEUS FORMATION IN REACTION ^{3}H(d,n)^{4}He FOR DEUTERONS OF LOW ENERGY. Sieminski, M.; Wilhelmi, Z.; Zupranski, P. (Inst. of Nuclear Research, Warsaw. Univ., Warsaw). Acta Phys. Pol.; B2: No. 4, 503-14(Jul-Aug 1971).

The results of measurements of the total and differential cross sections and of neutron polarization are analyzed in terms of a compound-nucleus contribution. The analysis performed seems to point to existence in ^{5}He of a positive-parity state $\frac{5}{2}^+$ at an excitation energy of about 20 MeV. (auth)

59707 BINDING ENERGY OF ^{3}H AND n–d DOUBLET SCATTERING LENGTH WITH A RANK-FOUR SEPARABLE POTENTIAL. Dabrowski, J.; Sworzecka, M. (Univ., Warsaw. International Centre for Theoretical Physics, Trieste, Italy). Acta Phys. Pol.; B2: No. 4, 395-422(Jul-Aug 1971).

Separable charge-independent nucleon–nucleon potentials containing an attraction and a hard-shell repulsion in the $^1S_0$ state and the Yamaguchi tensor interaction in the $^3S_1 + {}^3D_1$ state are used to calculate the ^{3}H ground-state energy, E_T, and the n–d doublet scattering length, ^2a. The potential that gives the best fit to the nucleon–nucleon data yields $E_T = -8.81$ MeV, $^2a = 0.58$ Fm. All results fall on the Phillips line. A derivation of the system of coupled integral equations for the bound state and for the scattering problem for an arbitrary rank potential acting in the $^1S_0$ and $^3S_1 + {}^3D_1$ states is also given. (auth)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 59248, 59355, 59523, 59692, 59693, 59696, 59697, 59703, 59743, 59761, 59767, 59771, 59754, 59783, 59785, 59827, 59849, and 59858.

59708 (BNWL-B-109) NEUTRON SPECTRA FROM (α,n) REACTIONS IN PLUTONIUM COMPOUNDS CALCULATED FROM HAUSER–FESHBACH REACTION THEORY. Lessor, D. L.; Schenter, R. E. (Battelle Pacific Northwest Labs., Richland, Wash.). Jun 1971. Contract AT(45-1)-1830. 39p. Dep. NTIS.

A sequence of computer programs was developed to calculate the yield and energy spectrum of neutrons from (α,n) reactions in materials having an alpha emitter in intimate contact with an (α,n) reacting nuclide. Alpha particle fluxes were calculated from emitter concentrations, alpha-decay lifetimes, and charged-particle stopping power of the material medium. Experimental (α,n) total cross sections were used where available, with branching ratios to final excitation states and angular distributions calculated from Hauser–Feshbach theory and optical-model penetrabilities. The neutron spectrum in PuO_2 and PuC with natural ^{17}O, ^{18}O, and ^{13}C isotopic composition was calculated for ^{238,239,240}Pu. (auth)

59709 (LA-DC-12389) NEW MEASUREMENTS OF (π^+,2p) REACTIONS ON LIGHT NUCLEI. Amato, J.; Burman, R. L.; Macek, R.; Oostens, J.; Shlaer, W. (Los Alamos Scientific Lab., N. Mex.); Arthur, E.; Sobottka, S. (Virginia Univ., Charlottesville); Lam, W.; Barnes, P. (Carnegie-Mellon Univ., Pittsburgh, Pa.); Fessenden, P.; (and others) (Oregon State Univ., Corvallis). [1971]. 4p. (CONF-710911-1). Dep. NTIS.

From fourth international conference on high energy physics and nuclear structure; Dubna (USSR).

Preliminary results of measurements of the (π^+,2p) reaction on lithium-6, nitrogen-14 and oxygen-16 at 70 MeV are presented. The excitation spectra are shown for these reactions. (J.F.P.)

59710 (LA-DC-12781) CROSS SECTIONS FOR (π^+,p) REACTIONS ON ^{9}Be, ^{12}C, AND ^{16}O. Amato, J.; Burman, R.; Macek, R.; Oostens, J.; Shlaer, W. (Los Alamos Scientific Lab., N. Mex.); Arthur, E.; Sobottka, S. (Virginia Univ., Charlottesville); Lam, W. C. (Carnegie-Mellon Univ., Pittsburgh, Pa.). [1971]. 4p. (CONF-710911-3). Dep. NTIS.

From fourth international conference on high energy physics and nuclear structure; Dubna, USSR (7 Sep 1971).

Upper limits were measured on (π^+,p) cross sections for beryllium-9, carbon-12, and oxygen-16 at 70 MeV. The excitation energy spectra are also shown. (J.F.P.)

59711 (UCLA-10-P-18-32) ON THE (p,^{4}He) REACTION MECHANISMS IN LIGHT NUCLEI. DeVries, Ralph M. (California Univ., Los Angeles. Dept. of Physics). Apr 1971. Contract AT(11-1)-Gen-10. 130p. Dep. NTIS.

The reactions (p,He-4) on beryllium-9 and boron-11 were measured. The angular distributions and differential cross sections are given. More than one mechanism seems to contribute to the measured cross sections. The triton pick-up and heavy particle pick-up mechanisms seem to be the most important. A coherent addition of these reaction amplitudes can reproduce the data reasonably well. (J.F.P.)

59712 PION–NUCLEUS SCATTERING FROM 120 MeV to 1200 MeV. Kohmura, Toshitake (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 46: No. 1, 167-72(Jul 1971).

The angular distribution and total cross section for pion-^{12}C scattering are analyzed in the energy region from 120 MeV to 1200 MeV. Phase shifts for pion-nucleon scattering are used in the Glauber type of analysis for high energy scattering. A nuclear form factor in a Gaussian form for ^{12}C, which gives an appropriate mean square of nuclear orbital radius $\langle r^2 \rangle$, is shown to reproduce the experimental data very well. (auth)

59713 COULOMB-NUCLEAR INTERFERENCE IN $\pi^- - {}^{12}$C ELASTIC SCATTERING. Binon, F.; Bobyr, V.; Duteil, P.; (and others) (Institut Interuniversitaire des Sciences Nucleaires, Mons, Belg. Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; B33: No. 1, 42-60(1971).

The $\pi^- - {}^{12}$C elastic differential cross sections were measured at three kinetic energies around the ($\frac{3}{2}$, $\frac{3}{2}$) pion–nucleon resonance, namely 120, 180 and 260 MeV, in the small-angle region $[t \leq 18\,000\ (\text{MeV}/c)^2]$ where the interference between Coulomb and nuclear amplitudes is most pronounced. An expression for the relative phase between Coulomb and nuclear amplitudes was derived which takes into account a variation linear in t of the nuclear phase. Using this formula, the real part of the forward nuclear amplitude was deduced from the data at each energy. The results are in good agreement with the predictions of pion–nucleus forward dispersion relations. The nuclear phase seems to vary significantly at 260 MeV. (auth)

59714 SELECTIVE POPULATION OF HIGHLY EXCITED STATES SEEN IN THE REACTION ^{12}C(^{16}O,p)^{27}Al. Cosman, E. R.; Sperduto, A.; Moore, W. H.; Chin, T. N.; Cormier, T. M.

(Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev. Lett.; 27: No. 16, 1074-7(18 Oct 1971).

The reaction $^{12}C(^{16}O,p)^{27}Al$ was studied at $E_{lab}(^{16}O) = 36$ and 60 MeV with high resolution. Narrow levels of ^{27}Al were seen in the region of $E_x = 13$ to 20 MeV in both measurements, and their locations suggest that the reaction is selectively sampling high-spin states in the region of the yrast line. (auth)

59715 $K^\pi = 1^+$ ROTATIONAL BAND IN ^{18}F. Rolfs, C.; Trautvetter, H. P.; Azuma, R. E.; Litherland, A. E. (Univ. of Toronto). Phys. Rev. Lett.; 27: No. 15, 1007-10(11 Oct 1971).

The 5298- and 6567-keV states in ^{18}F were studied by the reaction $^{14}N(\alpha,\gamma)^{18}F$. Spin assignments are made of $J^\pi = 4^+$ and 5^+, respectively. The energy and spin sequence of the 1702- (1^+), 2524- (2^+), 3358- (3^+), 5298- (4^+), and 6567-keV (5^+) states, as well as enhanced E2 strengths of the γ transitions between these states, show that these states can be considered to be members of a predominantly four-particle–two-hole $K^\pi = 1^+$ rotational band. A comparison between existing theories is given. (auth)

59716 EXPERIMENTAL DETERMINATION OF THE ^{12}Be GROUND-STATE MASS. Howard, Hillard H.; Stokes, Richard H.; Erkkila, B. H. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 27: No. 16, 1086-9(18 Oct 1971).

The ground-state mass of ^{12}Be was measured using the reaction $^7Li(^7Li,2p)^{12}Be$ in a kinematically complete experiment. The mass excess was determined to be 24.95 ± 0.10 MeV. An excited state of ^{12}Be is identified at an excitation energy of 0.81 ± 0.10 MeV. (auth)

59717 EVIDENCE FOR QUARTET STATES IN ^{20}Ne. Middleton, R.; Garrett, J. D.; Fortune, H. T. (Univ. of Pennsylvania, Philadelphia). Phys. Rev. Lett.; 27: No. 14, 950-2(4 Oct 1971).

Evidence from angular distributions and excitation functions for the reaction $^{12}C(^{12}C,\alpha)^{20}Ne$ suggests the identification of the 7.20-MeV 0^+ and 7.83-MeV 2^+ states in ^{20}Ne with the [220] quartet configuration—i.e., two sd-shell α particles outside a ^{12}C core. It appears that these states are populated via a "semidirect" mechanism that proceeds through the formation of doorway states in the incident channel. (auth)

59718 PRODUCTION OF THREE ^4He NUCLEI BY THE DIRECT INTERACTION OF ^6Li WITH ^6Li. Gadeken, L. L.; Norbeck, E. (Univ. of Iowa, Iowa City). Phys. Rev. Lett.; 27: No. 14, 952-6(4 Oct 1971).

The production of three ^4He nuclei directly, as well as via intermediate ^8Be states, was observed for the reaction $^6Li + {}^6Li$ at bombarding energies between 2.0 and 13.0 MeV. The large peaks attributed to direct effects in the energy spectra were fitted using a simple model that assumed an $\alpha + d$ cluster structure for the ^6Li nuclei and an interaction potential acting only between the deuterons. (auth)

59719 LIFETIME MEASUREMENTS OF THE EXCITED STATES IN ^{19}Ne AND ^{23}Mg. Itahashi, Takahisa; Shibata, Tokushi; Wakatsuki, Tetsuo (Osaka Univ.). J. Phys. Soc. Jap.; 31: No. 4, 961-6(Oct 1971).

$^{19}F(p,n)^{19}Ne$, $^{16}O(\alpha,n)^{19}Ne$, and $^{23}Na(p,n)^{23}Mg$ endothermic reactions have been used to determine the mean lives of the 1508 and 1536 keV states in ^{19}Ne and the 451 keV state in ^{23}Mg by the Doppler shift attenuation method. The results are $\tau = (1.4^{+0.5}_{-0.6}) \times 10^{-12}$ sec, $\tau = (2.8^{+1.8}_{-1.6}) \times 10^{-14}$ sec, and $\tau = (3.6^{+9.1}_{-2.4}) \times 10^{-12}$ sec, respectively. From the measurement of gamma-ray energies, the accurate energies of the excited states have been determined. (auth)

59720 ANALYSIS OF THE 14.1 MeV NEUTRON SCATTERING FROM ^{11}B. Ottaviani, P. L.; Zuffi, L. (CNEN, Bologna). Lett. Nuovo Cim.; 1: No. 26, 1114-17(26 Jun 1971).

The angular distributions for 14.1-MeV neutrons scattered from the first five states of ^{11}B are analyzed by using unified-model wave functions in a coupled-channels calculation. The matrix elements of the interaction potential that are involved in the calculations are assumed to be those of a nonspherical optical-model potential when dealing with states belonging to the same intrinsic configuration and as being those of a two-body effective potential when dealing with states belonging to different intrinsic configurations. (R.W.R.)

59721 $^9Be(d,\alpha_0)^7Li$ (GROUND STATE) AND $^9Be(d,\alpha_1)^7Li^*$ (470 keV) REACTIONS IN THE 0.9- TO 2.2-MeV ENERGY RANGE. Saganek, A.; Sledzinska, I.; Turos, A.; Wilhelmi, Z.; Zwieglinski, B. (Univ., Warsaw. Inst. of Nuclear Research, Warsaw). Acta Phys. Pol.; B2: No. 4, 473-88(Jul-Aug 1971).

Angular distributions and total cross sections for $^9Be(d,\alpha_0)^7Li$ (ground state) and $^9Be(d,\alpha_1)^7Li^*$ (470 keV) reactions were measured over the angular range from 15° to 165° (lab) in 100-keV steps. A detailed description of the experimental technique is given. The observed behavior of angular distributions does not allow univocal determination of the dominating reaction mechanism. The revealed features of the reactions in question indicate that these reactions may proceed through overlapping opposite-parity levels of the compound nucleus ^{11}B, and one of them is probably centered at the excitation energy $E_k \approx 17.3$ MeV. However, direct pick-up and heavy-particle stripping may be responsible as well. (auth)

59722 ENERGY DEPENDENCE OF POLARIZATION IN $^9Be(d,p)^{10}Be$ REACTION. Kozlowski, M. (Univ., Warsaw). Acta Phys. Pol.; B2: No. 4, 515-19(Jul-Aug 1971).

The polarization of protons from the reaction $^9Be(d,p)^{10}Be$ is analyzed. It is shown that the predictions based on the invariance of the density matrix under the exchange of distorted waves (when $p_d r_d = p_d r_d$) are in qualitative agreement with the experimental data. The usefulness of the DWBA for the describing of the polarization in the energy range 2 to 10 MeV is also discussed. (auth)

59723 SHELL-MODEL DATA FROM A REALISTIC N–N INTERACTION. III. SELF-CONSISTENT STARTING ENERGIES. Irvine, J. M.; Pucknell, V. F. E. (Univ. of Manchester, Eng.). Nucl. Phys.; A174: No. 3, 634-40(1971).

It is shown that the inclusion of higher-order corrections in the Goldstone expansion together with a self-consistent treatment of the starting energy leads to improved values for the ground-state binding energies in ^{60}O and ^{40}Ca. At the same time, excellent agreement is obtained between the calculated and experimental single-particle energies. Using these calculated single-particle energies and reaction matrix elements in a RPA calculation leads to an improved description of the negative-parity states in these nuclei. (auth)

59724 REACTION MATRIX THEORY FOR CLUSTER STATES IN LIGHT NUCLEI. II. CLUSTERING DEPENDENCE OF THE EFFECTIVE INTERACTION. Bando, Hiroharu; Nagata, Sinobu; Yamamoto, Yasuo (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 5, 1515-26(May 1971).

The states with triangular and linear-chain configurations of three α clusters in ^{12}C are treated by the reaction-matrix theory on the basis of a realistic nuclear force. Clustering dependence of the G matrix is found to be essential for clusterization. It also brings on a change of effective interaction between the two configurations, which has a role in reducing the excitation energy of the linear-chain state. Its origin is mainly in the triplet even state tensor force. (auth)

59725 BINDING ENERGIES OF ALPHA-PARTICLE NUCLEI. Sood, P. C.; Joshi, P. C. (Banaras Hindu Univ., India). Progr. Theor. Phys. (Kyoto); 45: No. 5, 1697-8(May 1971).

Examination of the $\alpha-\alpha$ interaction (in analogy with the nucleon–nucleon interaction) shows that the ratio of the intra α to the inter α (residual) binding energy of alpha-particle nuclei approaches a constant value; this behavior indicates an asymptotic saturation of the residual binding energy. If a 2α structure is assumed to have zero binding, a least-squares fit to the residual binding energy $(B.E.)_\alpha$ yields $(B.E.)_\alpha = (7.315 \pm 0.122)(N_\alpha - 2)$ MeV. If an effective α number $N_\alpha^{eff} = N_\alpha - 2$ is defined, it may be stated that the residual binding energy per effective α is a constant. It is shown that the $\alpha-\alpha$ force saturates in going from the unbound system for $N_\alpha = 2$ to the 3α nucleus ^{12}C and, thereafter, except for a minimum for ^{20}Ne (explainable in terms of the geometrical arrangement of various alphas), the curve shows little fluctuation; this behavior is in contrast to that of the binding-energy-per-nucleon curve, which shows distinct subshell structure. The saturation values in both cases are very nearly the same. (R.W.R.)

59726 VARIATIONAL CALCULATION OF ^{16}O IN THE α-PARTICLE MODEL. Mendez V., Rosa Ma. (UNAM, Mexico City); Seligman, T. H. Phys. Lett.; 36B: No. 4, 307-8(20 Sep 1971).

The low lying 0^+ states of ^{16}O are investigated in the α-particle model using a recent $\alpha-\alpha$ potential. Variational methods are employed and a translationally invariant harmonic oscillator basis is used, including 40 states up to 10 quanta. (auth)

59727 ELASTIC SCATTERING OF 1 GeV PROTONS FROM ^{12}C USING THE α-PARTICLE MODEL. Ahmad, I. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett.; 36B: No. 4, 301-4(20 Sep 1971).

Glauber multiple scattering theory is applied to study the elastic scattering of 1 GeV protons on ^{12}C using the α-particle model. Under some approximations it is shown that the model gives a reasonably good account of the experimental data. (auth)

59728 SHAPE MIXING IN ^{24}Ne. Khadkikar, S. B.; Nair, S. C. K.; Pandya, S. P. (International Centre for Theoretical

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Physics, Trieste, Italy). Phys. Lett.; 36B: No. 4, 290-2(20 Sep 1971).

It is possible to understand the apparent non-rotational feature of the spectrum of ^{24}Ne by mixing the nearly degenerate prolate and oblate Hartree-Fock solutions in a projection calculation provided the important particle-hole excitations in both states are also included. (auth)

59729 HIGH-ENERGY ELECTRON AND PROTON SCATTERING AND DEFORMATION OF ^{12}C NUCLEUS. Ciofi Degli Atti, C.; Guardiola, R. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett.; 36B: No. 4, 287-9(20 Sep 1971).

It is shown that the deformed nuclear model recently used to interpret the high-energy proton scattering from ^{12}C is unable to explain the high-energy electron scattering from the same nucleus. (auth)

59730 RADIATIVE PION CAPTURE IN ^{12}C. Skupsky, S. (Argonne National Lab., Ill. Univ. of Chicago). Phys. Lett.; 36B: No. 4, 271-4(20 Sep 1971).

Transition rates for the reaction π^- (at rest) + ^{12}C (ground) → γ + ^{12}B (even parity) have been computed in the impulse approximation with Cohen-Kurath wave functions for the nuclear states involved. The two available experiments disagree by a factor of 5 in the ground-state transition rate. The calculated rates agree closely with the results of Bistirlich et al. (auth)

59731 MAGNETIC ANALYSIS OF THE REACTIONS ^{7}Li(^{3}He,d)^{8}Be AND ^{7}Li(^{3}He,t)^{7}Be. Piluso, C. J.; Spear, R. H.; Carter, K. W.; Kean, D. C.; Barker, F. C. (Australian National Univ., Canberra). Aust. J. Phys.; 24: 459-69(Aug 1971).

The reactions ^{7}Li(^{3}He,d)^{8}Be and ^{7}Li(^{3}He,t)^{7}Be have been studied at a bombarding energy of 15 MeV. Energy spectra of deuterons and tritons were measured at laboratory angles of 10° and 25° using a broad-range magnetic spectrograph. In the range of excitation energies from 0 to 18 MeV in ^{8}Be, no evidence was found for the existence of previously unreported narrow states that are suggested by systematics and simple models. The measured position and width of the 2.9 MeV 2^+ level of ^{8}Be are in good agreement with values obtained previously from the reaction ^{9}Be(p,d)^{8}Be, suggesting that the broad 2^+ states at higher excitation energies have little 1p-1h character. The deuteron spectra in the neighborhood of the 16.6 and 16.9 MeV levels of ^{8}Be show interference effects which agree well with shell model predictions. The width of the 4.55 MeV $\frac{7}{2}^-$ level of ^{7}Be was found to be 175 ± 7 keV, which differs considerably from the previously reported value. (auth)

59732 FURTHER STRUCTURE IN THE GIANT RESONANCE REGION OF ^{12}C. Ward-Smith, D. F. (Univ. of Melbourne). Aust. J. Phys.; 24: 453-8(Aug 1971).

A calculation has been made of the dipole states of ^{12}C which, in addition to structure centered around 22 and 25.5 MeV in the giant resonance region, predicts further structure at about 30 MeV. The wavefunction of this state shows that it is basically the main giant resonance state coupled to the 0^+ second excited low-lying state in ^{12}C at 7.65 MeV. This result is in agreement with the recent suggestion of Owen and Spicer. In showing this to be so, a particular form for the coupling Hamiltonian has been adopted which shows the insensitivity of the results to matrix elements of the low-lying states. It is suggested that this may indicate how calculations using the experimental energy values for the low-lying excited states together with various forms for the wavefunctions of these states can all give results which are in agreement with experiment. (auth)

59733 CROSS SECTIONS FOR THE PRODUCTION OF BERYLLIUM ISOTOPES FROM THE 880 MeV ALPHA-PARTICLE BOMBARDMENT OF CARBON. Lestringuez, J.; Raisbeck, G. M.; Yiou, F.; Bernas, R. (CNRS, Orsay, France). Phys. Lett.; 36B: No. 4, 331-6(20 Sep 1971).

The cross sections for the production of ^{9}Be and ^{10}Be from the 880 MeV α-particle bombardment of carbon have been measured to be 10.6 ± 1.7 and 6.5 ± 1.4 mb. These values are essentially twice the high-energy proton cross sections. It is shown that the effect of the interstellar helium on the distribution of beryllium isotopes in cosmic rays is thus less important than had been anticipated. (auth)

59734 (γ,α) REACTION EXPERIMENT. Abe, Ken (Tohoku Univ., Sendai); Tsubota, Hiroaki; Kawamura, Nobuaki. Kakuriken Kenkyu Hokoku; 3: No. 1, 56-9(Oct 1970). (In Japanese).

The (γ,α) reactions for C (polyethylene), C + O (cellophane) and Be targets were studied. It was found that the inverse bias voltage giving the best discriminating capability differed sharply from detector to detector, even for the same types. At present, the greatest problem in the (γ,α) reaction experiment is: how far can a reaction chamber be advanced? In the present work, the reaction chamber was set inside a concrete wall behind BOM, and shielded with Pb bricks. Pulse-height spectra were tentatively obtained from C. C + O and Be targets under this shielding condition showed that the results are satisfactory. (Japan)

59735 NEUTRON-^{8}Be FINAL-STATE INTERACTION IN THE BREAKUP OF ^{9}Be. Jeremie, H. (Univ. of Montreal). Can. J. Phys.; 49: 2085-8(1 Aug 1971).

The shape of a peak in the ^{9}Be(p,p′)^{9}Be* → ^{8}Be + n reaction, as measured by Spencer et al., was calculated according to final-state interaction theory using the effective-range approximation. The value of the neutron-^{8}Be scattering length thus obtained is $|a_n - {}^8\mathrm{Be}| = 40^{+10}_{-5}$ fm corresponding to a relative excitation energy of 14.5 ± 5 keV. (auth) (Canada)

59736 STUDY OF NUCLEI BY ELECTRON SCATTERING. Torizuka, Yoshiharu; Kimura, Motoharu; Kojima, Yuzo; Oyamada, Masayuki; Nakahara, Kazuo (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 1, 1-33(Oct 1970). (In Japanese).

Studies on excited states of ^{12}C, ^{16}O, ^{20}Ne, ^{24}Mg and ^{28}Si were carried out. Experimental results of ^{40}Ca obtained previously were analyzed in detail. A scattering experiment was performed to separate longitudinal components of shape factor from transverse components in the excited states of ^{12}C. The results were compared with theoretical results according to the independent particle model given by de Forest, and good agreement was obtained. It was impossible to distinguish between one-particle excitation and quasielastic scattering in this excitation energy range. Measurements were extended to the higher momentum transfer (q) region, and the results showed a discrepancy between the experiment and the shape factor of 2^- state at 20.6 MeV calculated from the 1p-1h model. The shape factors of second 1^+ and first 3^+ levels with intermediate coupling model had the same q dependence as the experiment, and the absolute values were in agreement with the experiment. Cross sections for peaks at 13.1, 15.3, 18.6 and 19.1 MeV of ^{16}O were observed, and longitudinal components were separated from transverse components. All the peaks show complex q dependence, and mixing of levels was considered. Elastic scattering and inelastic scattering at 1.63, 4.25 and 5.6 MeV levels of ^{20}Ne were observed. The result of elastic scattering was analyzed with charge distribution of shell model. The charge distribution of ^{20}Ne was investigated with a rigid body model. Reduced transition probabilities were obtained for ^{24}Mg. Transition probabilities for low-lying states of ^{40}Ca were successfully explained by the shell model. (Japan)

59737 INVESTIGATION OF THE ^{6}Li($\vec{d},\alpha$)^{4}He REACTION WITH POLARIZED DEUTERONS. Neff, R.; Huber, P; Naegele, H. P.; Rudin, H.; Seiler, F. (Univ., Basel). Helv. Phys. Acta; 44: No. 5, 679-91(15 Aug 1971). (In German).

The vector and tensor analyzing power of the ^{6}Li(d,α)^{4}He-reaction for polarized incident deuterons have been measured at 400, 600, 800 and 960 keV mean deuteron energies. The four independent components $A_y(\vartheta)$, $A_{zz}(\vartheta)$, $A_{xx}(\vartheta)-A_{yy}(\vartheta)$ and $A_{xz}(\vartheta)$ are fitted by the appropriate associated Legendre functions. It is shown that the results can be explained by the assumption of three states with $J^\pi = 2^+$, 4^+ and 0^+. (auth)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 57796, 57901, 58336, 59248, 59355, 59397, 59692, 59693, 59696, 59697, 59714, 59719, 59723, 59725, 59736, 59780, 59783–59785, 59789, 59797, 59822, 59841, and 59848.

59738 (JINR-P1-6029) ANGULAR DISTRIBUTION OF LOW-ENERGY NEUTRONS FROM NUCLEAR μ-CAPTURE IN SULFUR AND CALCIUM. Voitkovska, I.; Evseev, V. S.; Kozlovski, T.; Nikolina, A. A.; Roganov, V. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The dependence of the coefficient of asymmetry B (in the angular distribution of neutrons from the nuclear μ^--capture in sulfur and calcium) on the energy of recoil protons in the range of 2.5 + 10 MeV (sulfur) and 2 + 17 MeV (calcium) is measured by the method of the meson spin precession in the magnetic field. The values of B are close to zero which does not contradict the up-to-date models of nuclear capture. (auth)

59739 (ORNL-TM-3591) ELASTIC SCATTERING OF 40-MeV PROTONS FROM ^{48}Ti, $^{\mathrm{nat}}$Cr, AND ^{64}Zn: TABULATED DIFFERENTIAL CROSS SECTIONS. Dickens, J. K.; Gross, E. E.; Perey,

F. G.; Van der Woude, A.; Zucker, A. (Oak Ridge National Lab., Tenn.). 7 Oct 1971. 9p. Dep. NTIS.

Numerical values of differential cross sections for elastic scattering of 40-MeV protons from targets of ^{48}Ti, ^{nat}Cr, and ^{64}Zn for scattering angles between 10 and 145 degrees are reported in tabular form. (auth)

59740 POSSIBILITY OF TWO-PROTON AND TWO-NEUTRON RADIOACTIVE DECAY FROM MANY-PARTICLE ISOMERIC STATES OF NUCLEI. Gol'danskii, V. I.; Peker, L. K. (Inst. of Chemical Physics, Moscow. Inst. of Metrology, Moscow). JETP Lett. (USSR) (Engl. Transl.); 13: No. 10, 412-14(20 May 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 10, 577-8(20 May 1971).

Possible three- and four-particle isomers with large angular momenta for spherical nuclei with even A are considered, and the question of the probability of observing two-proton decay of such many-particle isomers is analyzed. The following examples of two-proton decay are presented: ^{47m}Fe($^{17}/_{2}{}^{-}$) → ^{45}Cr*($^{3}/_{2}{}^{+}$), ^{82m}Mo(16^{+}) → ^{80}Zr(0^{+}), ^{96}Cd(16^{+}) → ^{94}Pd(0^{+}), ^{106}Te(12^{+}) → ^{104}Sn(0^{+}), and ^{108}Te(12^{+}) → ^{106}Sn(0^{+}). The role of the centrifugal barrier in the observed decay rate turns out to be, in general, no less important than the role of the Coulomb barrier (e.g., a change of 12 units in the angular momentum in 2p decay of the isotopes of Te lengthens the decay time, at a total energy of the two emitted protons of 1 to 3 MeV, by approximately 10 orders of magnitude). Large centrifugal barriers can ensure the possibility of observing a number of cases of relatively long-period two-neutron radioactive decay of many-particle isomeric states of neutron-rich nuclei, for example, ^{70}Ti(14^{+}) → ^{68}Ti(0^{+}) and ^{78}Fe(12^{+}) → ^{76}Fe(0^{+}), if the energy of the emitted pairs of neutrons is sufficiently small. (R.W.R.)

59741 ANGULAR DISTRIBUTIONS FOR $T_{np} = 1$ AND $T_{np} = 0$ TRANSFERS IN (^{3}He,p) REACTIONS. Meyer-Schuetzmeister, L.; Gemmell, Donald S. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 27: No. 13, 869-72(27 Sep 1971).

Angular distributions of (^{3}He,p) reactions are investigated for some odd–even target nuclei, which allow orbital–angular-momentum transfers $L_{np} = 0,2$ for $T_{np} = 0,1$ transitions. "Pure" $L_{np} = 0$ distributions are observed for the n–p pair transfer with $T_{np} = 1$ leading to the analog state and to the corresponding state with the same nucleon configuration but with $T = T_{<}$. "Mixed" $L_{np} = 0 + 2$ distributions are observed for $T_{np} = 0$ transfers. (auth)

59742 SYMMETRY ENERGY FOR COLLECTIVE DIPOLE EXCITATION. Paul, P.; Amann, J. F.; Snover, K. A. (State Univ. of New York, Stony Brook). Phys. Rev. Lett.; 27: No. 15, 1013-16(11 Oct 1971).

Results from radiative proton capture in several nuclei near $A \approx 60$ and $A \approx 90$ show that the displacement energies of the T + 1 and T isospin components of the collective electric dipole states are well described by a collective symmetry energy $U = T\widetilde{V}/A$ with a value of $\widetilde{V} = 58 \pm 5$ MeV. The specific cases of ^{49}Sc and ^{64}Zn are discussed. (auth)

59743 REACTION ^{12}C(^{14}N,^{6}Li)^{20}Ne AND THE STRUCTURE OF THE UPPER $K = 0^{+}$ BANDS. Nagatani, K. (Brookhaven National Lab., Upton, N. Y.); Le Vine, M. J.; Belote, T. A.; Arima, A. Contract AT(30-1)-2098. Phys. Rev. Lett.; 27: No. 16, 1071-4(18 Oct 1971).

The reaction ^{12}C(^{14}N,^{6}Li)^{20}Ne was studied at 60 MeV, and forward-angle reaction data to states of ^{20}Ne were obtained. Different rotational bands were populated with different strengths consistent with cluster-transfer processes. The previously questioned structure of the $K = 0^{+}$ bands starting near 7 MeV is discussed, and a new classification for the bands is proposed. (auth)

59744 OPTICAL POTENTIAL FOR NUCLEON SCATTERING ON ^{40}Ca. Bruneau, M.; Vinh Mau, N. (Institut de Physique Nucleaire, Orsay, France). pp 333-40 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

59745 MEASUREMENT OF THE LINEAR POLARIZATION OF LOW-ENERGY CAPTURE γ-RAYS FROM THE ^{35}Cl(n,γ) REACTION. Honzatko, J.; Kajfosz, J.; Kosina, Z. (Nuclear Research Inst., Rez, Czech.). Nucl. Phys.; A174: No. 3, 668-72(1971).

The 0.79- and 1.17-MeV levels of ^{36}Cl and the associated γ transitions following thermal-neutron capture were studied. From measurements of the correlation between direction and linear polarization of γ rays, the following spins and E2/M1 mixing ratios δ_1 (for primary transitions) and δ_2 (for secondary transitions) were found: for the 0.79-MeV level $J^{\pi} = 3^{+}$, $\delta_1 = 0.210 \pm 0.004$, $\delta_2 = -1.1 \pm 0.4$ and for the 1.17-MeV level $J^{\pi} = 1^{+}$, $\delta_1 = -0.47 \pm 0.10$, $\delta_2 = 0.32 \pm 0.06$. (auth)

59746 CIRCULAR POLARIZATION OF GAMMA RADIATION FROM ^{58}Co, ^{48}V, ^{52}Mn, AND ^{56}Co. Pingot, O. (Institut Interuniversitaire des Sciences Nucleaires, Mons, Belg.). Nucl. Phys.; A174: No. 3, 627-33(1971). (In French).

The β–γ circular polarization correlation of the cascades $2^{+}(\beta^{+}\ 472\ \text{keV})2^{+}(\gamma\ 810)0^{+}$ in ^{58}Co, $4^{+}(\beta^{+}\ 690)4^{+}(\gamma\ 1312)2^{+}(\gamma\ 983)0^{+}$ in ^{48}V, $6^{+}(\beta^{+}\ 580)6^{+}(\gamma\ 744)4^{+}(\gamma\ 935)2^{+}(\gamma\ 1434)0^{+}$ in ^{52}Mn, and $4^{+}(\beta^{+}\ 1500)4^{+}(\gamma\ 1240)2^{+}(\gamma\ 847)0^{+}$ in ^{56}Co was studied by using a Compton-effect polarimeter. The measured asymmetry parameters are -0.167 ± 0.004, -0.081 ± 0.003, -0.057 ± 0.003, and -0.085 ± 0.003, respectively. (auth)

59747 DECAY OF ^{68}As. Paradellis, T.; Houdayer, A.; Mark, S. K. (McGill Univ., Montreal). Nucl. Phys.; A174: No. 3, 617-26(1971).

^{68}As was produced via the ^{70}Ge(p,3n)^{68}As reaction. Twenty γ rays associated with the decay of ^{68}As were observed. Seventeen of these γ rays are placed into a decay scheme, which includes excited states in ^{68}Ge at 1016.5, 1778.7, 2269.8, 2429.4, 2454.0, 2650.5, 3788.0, 4075.0, and 4236.9 keV. The half-life of ^{68}As was measured to be $t_{1/2} = 159 \pm 4$ sec. (auth)

59748 LEVELS IN ^{76}Se POPULATED IN THE β-DECAY OF ^{76}As. McMillan, D. K.; Pate, B. D. (Simon Fraser Univ., Burnaby, British Columbia). Nucl. Phys.; A174: No. 3, 604-16 (1971).

Energies and intensities for 25 γ rays from ^{76}As decay were measured with Ge(Li) detectors. New data on γ rays at 563.5, 981.2, and 1213.5 keV plus β–γ and γ–γ coincidence measurements allow proposal of a revised ^{76}As decay scheme with ^{76}Se levels at 559.6, 1123.1, 1217.0, 1332.1, 1690.1, 1788.5, 2059, 2127.6, 2172.6, 2430.5, 2516, 2657.1, 2671.5, and 2866 keV. (auth)

59749 DECAY OF ^{80}As. McMillan, D. K.; Pate, B. D. (Simon Fraser Univ., Burnaby, British Columbia). Nucl. Phys.; A174: No. 3, 593-603(1971).

The energies and relative intensities of 20 γ rays following the β decay of ^{80}As were measured using a 23.8-cm^{3} Ge(Li) spectrometer. These data plus γ–γ coincidence results were used to construct a level scheme for ^{80}Se containing 12 excited levels at 665.8, 1448.8, 1477.1, 1872.6, 1960.1, 2310.9, 2514.0, 2774.2, 2836.2, 3024.0, 3606.1, and 3726.6 keV. The half-life of ^{80}As was measured to be 16.5 ± 0.3 sec. (auth)

59750 DISTRIBUTION OF $T_{<}$ STATES IN ^{89}Y. Vourvopoulos, G. (Florida A and M Univ., Tallahassee. Technion-Israel Inst. of Tech., Haifa); Shoup, R.; Brown, R. A. Nucl. Phys.; A174: No. 3, 581-92(1971).

^{88}Sr(^{3}He,d)^{89}Y data taken with the Oak Ridge Isochronous Cyclotron with $E^{3}_{He} = 25$ MeV are analyzed. Between 3.7 and 7.7 MeV excitation a large number of states is observed with $l_p = 2$ and $l_p = 0$. These states are considered to be antianalog states, mixed with core-polarization states. (auth)

59751 LIFETIME MEASUREMENTS IN sd SHELL NUCLEI VII. MEAN LIVES OF ^{27}Si AND ^{27}Al LEVELS. Mauritzson, I. (Rijksuniversiteit, Utrecht); Engmann, R.; Brandolini, F.; Barci, V. Nucl. Phys.; A174: No. 3, 572-80(1971).

The mean lives and excitation energies of the six lowest levels of ^{27}Si were measured by means of the ^{28}Si($\tau,\alpha\gamma$)^{27}Si reaction. Coincidence Doppler-shift-attenuation measurements led to mean lives of $\tau_m = 2200 \pm 400$, 56 ± 12, 16 ± 8, <10, and 79 ± 11 fsec for the ^{27}Si levels at $E_x = 0.96$, 2.17, 2.65, 2.87, and 2.91 MeV, respectively. With the recoil-distance method applied to the ^{24}Mg(α,n)^{27}Si and ^{24}Mg(α,p)^{27}Al reactions, the mean lives of the 0.78-MeV level in ^{27}Si and the 0.84-MeV level in ^{27}Al were measured to be $\tau_m = 50 \pm 6$ psec and 48 ± 3 psec, respectively. Branchings were measured for the states at $E_x = 2.17$, 2.65, 2.87, and 2.91 MeV in ^{27}Si. From the presently known information it is possible to assign positive parity to the level at 2.17 MeV. The spectroscopic data on the A = 27 mirror nuclei are compared with the results of many-particle shell-model calculations. (auth)

59752 NEW VIRTUAL AND ANALOGUE STATES IN ^{47}V. Kaestner, F. (Institut fuer Experimentalphysik, Hamburg); Buchholz, K.; Klapdor, H. V. Nucl. Phys.; A174: No. 3, 552-60(1971). (In German).

In an investigation of $T = {}^{3}/_{2}$ analog states in ^{47}V the ^{46}Ti(p,γ)^{47}V excitation function was measured for proton bombarding energies $E_p = 1350$ to 2280 keV. One hundred twenty-three new virtual levels were found in the excitation region $E^{*} = 6.5$ to 7.4 MeV in ^{47}V. The average level spacing in this region is determined to be $D \approx 6$ keV. Some prominent resonances are tentatively interpreted as

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isobaric analog states corresponding to parent states in the excitation region $E^* \approx 2.3$ to 3.3 MeV in ^{47}Ti. (auth)

59753 PRODUCTION OF ^{26}Al AND ^{22}Na FROM PROTON BOMBARDMENT OF Si, Al, AND Mg. Furukawa, M. (Nagoya Univ., Japan); Shizuri, K.; Komura, K.; Sakamoto, K.; Tanaka, S. Nucl. Phys.; A174: No. 3, 539-44(1971).

The formation cross sections of ^{26}Al and ^{22}Na from proton bombardment of natural Si, Al, and Mg were measured as a function of E_p up to $E_p = 52$ MeV. The maximum values for ^{26}Al formation from natural Si, Al, and Mg are 60 mb at 44 MeV, 169 mb at 23 MeV, and 12.6 mb at 11.3 MeV, respectively. The excitation functions for the ^{22}Na formation are compared with those of previous experiments. (auth)

59754 ELASTIC AND INELASTIC SCATTERING OF 80-MeV DEUTERONS. Duhamel, G.; Marcus, L.; Langevin-Joliot, H.; (and others) (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A174: No. 3, 485-96(1971). (In French).

Deuteron elastic scattering by ^{12}C, ^{24}Mg, ^{27}Al, ^{58}Ni, ^{68}Zn, ^{89}Y, ^{120}Sn, and ^{208}Pb was studied in order to obtain optical-potential parameters. The inclusion of a vector spin–orbit potential is necessary for nuclei with $A \geqq 89$. Experimental angular distributions can also be well fitted without such a potential for light nuclei. The first 2^+ levels of ^{12}C, ^{58}Ni, ^{68}Zn, and ^{120}Sn and the first 3^- level of ^{12}C were observed; and the angular distribution of scattered deuterons analyzed by DWBA. Experimental deformation parameters are deduced. The $^{12}C(d,p)^{13}C$ reaction was studied. Experimental and calculated angular distributions to the first levels are compared. (auth)

59755 SOME (n,p) CROSS-SECTIONS OF ^{46}Ti, ^{47}Ti, AND ^{48}Ti. Ghorai, S. K.; Cooper, J. R.; Moore, J. D.; Alford, W. L. (Auburn Univ., Ala.). J. Nucl. Energy; 25: No. 8, 319-20(Aug 1971).

Activation techniques were used to measure the (n,p) cross sections of ^{46}Ti, ^{47}Ti and ^{48}Ti relative to the known cross section for the $^{27}Al(n,p)^{27}Mg$ reaction. The measured cross sections and the incident neutron energies were: 149 mb at 6.1 MeV, 106 mb at 5.0 MeV, and 46 mb at 4.1 MeV for ^{46}Ti; 135 mb at 6.1 MeV, 93 mb at 5.0 MeV, 86 mb at 4.1 MeV, and 68 mb at 3.4 MeV for ^{47}Ti, and 2.4 mb at 6.1 MeV for ^{48}Ti. (auth)

59756 SPIN AND PARITY OF SOME EXCITED STATES OF ^{48}Sc. Cambi, A.; Fazzini, T.; Giannatiempo, A.; Maurenzig, P. R. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Lett. Nuovo Cim.; 2: No. 11, 537-40(11 Sep 1971).

The γ and conversion electron spectra from the $^{48}Ca(p,n\gamma)$ reaction at $E_p = 1964$ and 1975 keV were studied using solid-state detectors. The conversion electrons were analyzed using a magnetic spectrometer. Internal conversion coefficients for several transitions in ^{48}Sc were determined. Spin and parity assignments for the 1143- and 1402-keV levels were made. (J.W.R.)

59757 LOW LYING 8 AND 12 HOLE STATES IN LIGHT NUCLEI. Strottman, D. (Nuclear Physics Lab., Oxford). Phys. Lett.; 36B: No. 4, 321-4(20 Sep 1971).

The positions of 4, 8 and 12 hole states in alpha particle nuclei from ^{20}Ne to ^{52}Fe are calculated using a j dependent monopole–monopole interaction with an A^{-1} dependence. The 12 hole states in ^{40}Ca and ^{44}Ti are lower than the 8 hole states and are calculated to be at 5 and 3 MeV respectively. B(E2)'s are calculated for ^{40}Ca and the nature of the 5.21 MeV state is discussed. (auth)

59758 INELASTIC EFFECTS IN THE $^{20}Ne(d,^3He)^{19}F$ REACTION. Dudek, A.; Edens, D. J. (Nuclear Physics Lab., Oxford). Phys. Lett.; 36B: No. 4, 309-12(20 Sep 1971).

The importance of semidirect contributions to the $^{20}Ne(d,^3He)^{*19}F$ (2.78) reaction is studied by using the coupled-channels formalism for inelastic scattering reactions in both the incoming and outgoing channels. The magnitude and shape of the differential cross section of the reaction to the $9/2^+$ level in ^{19}F can be well explained by the addition of inelastic effects in both reaction channels. (auth)

59759 MEASUREMENTS OF γ-RADIATION FOLLOWING keV NEUTRON CAPTURE IN ZINC. Bird, J. R. (Australian Atomic Energy Commission Research Establishment, Sutherland). Aust. J. Phys.; 24: 487-95(Aug 1971).

Gamma-ray spectra following the capture of 10 to 80 keV neutrons in natural zinc are reported. The results give information on γ-ray transitions and energy levels in ^{65}Zn, ^{67}Zn, ^{68}Zn, and ^{69}Zn. Positive and negative parity final states with angular momenta up to $5/2$ are populated, indicating the presence of p- and/or d-wave capture. There is little correlation between reduced widths for keV capture and (d,p) reactions and the importance of single-particle effects is reduced by comparison with capture in lighter nuclei. (auth)

59760 STUDY OF RESONANCES IN THE $^{29}Si(p,\gamma)^{30}P$ REACTION. Din, G. U.; Davis, J. R. (Australian National Univ., Canberra). Aust. J. Phys.; 24: 497-518(Aug 1971).

Gamma-ray decay schemes of 14 resonances in the $^{29}Si(p,\gamma)^{30}P$ reaction in the range $E_p = 900–2120$ keV have been obtained with high resolution Ge(Li) detectors. Consistent resonance decay schemes have been derived along with decay schemes of bound levels. Decay to bound levels at 3.84, 4.74, 4.94, 5.21, 5.51, and 5.70 MeV has been observed in this reaction for the first time, while new results have been obtained for the decay of some of the bound levels. The reported level at 4.468 MeV is confirmed. The decay schemes of the $E_p = 1110$, 1664, 1850, 197[illegible], and 2070 keV resonances indicate that they are predominantly T = 0 levels, whereas the 2105 and 2115 keV resonances are probably the split analogs of a T = 1 level in ^{30}Si. (auth)

59761 SEARCH FOR HIGH-SPIN STATES IN ^{27}Al. Carter, K. W.; Kean, D. C.; Piluso, C. J.; Spear, R. H. (Australian National Univ., Canberra). Aust. J. Phys.; 24: 471-85(Aug 1971).

A search has been made for high-spin states in ^{27}Al in the range of excitation energies E_x from 4.8 to 8.0 MeV using the reactions $^{12}C(^{16}O,p)^{27}Al$ and $^{24}Mg(\alpha,p)^{27}Al$. Gamma-ray branching ratios and proton–gamma angular correlations have been measured for prospective high-spin states. Although no unambiguous spin and parity assignments have been obtained, it is argued that states at $E_x = 5499$, 6716, 6952, 7226, and 7441 keV probably have spins and parities $11/2^+$, $9/2^+$, $11/2^+$, $9/2^\pm$ or $11/2^+$, and $13/2^+$ respectively. An attempt is made to interpret the results in terms of the strong-coupling rotational model. (auth)

59762 $^{27}Al(p,\gamma)^{28}Si$ RESONANCES FOR PRECISE CALIBRATION OF HIGH ENERGY GAMMA RAYS. Holmberg, P.; Kiuru, A. (Helsinki Univ.). Commentat. Phys.-Math.; 40: 135-9(1970).

Accurate measurements of gamma-ray energies in the 0.5–10.7 MeV range, occurring in the decay of the resonances at $E_p = 991.82$ keV and 1118.4 keV in the $^{27}Al(p,\gamma)^{28}Si$ reaction were performed. Precise energies of nine bound states were obtained and the Q-value for the reaction was determined as $Q = 11586.3 \pm 0.3$ keV. (auth) (Finland)

59763 ENERGY DETERMINATIONS OF GAMMA RAYS AND NEW WEAK TRANSITIONS IN THE DECAY OF ^{56}Co. Kiuru, A.; Holmberg, P.; Siivola, A. (Helsinki Univ.). Commentat. Phys.-Math.; 40: 113-17(1970).

Precise energies of 33 gamma rays following the decay of 77-day ^{56}Co were determined. Four weak gamma rays earlier reported were confirmed and four new, weak transitions were found and placed in the decay scheme. (auth) (Finland)

59764 PROPERTIES OF NUCLEAR LEVELS AND TRANSITIONS IN ODD COPPER ISOTOPES. PART 2. THE $^{60}Ni(p,\gamma)^{61}Cu$ REACTION. Kiuru, A.; Holmberg, P.; Viitasalo, M. (Helsinki Univ.). Commentat. Phys.-Math.; 41: No. 2, 55-72(Jun 1971).

The $^{60}Ni(p,\gamma)^{61}Cu$ reaction were investigated at $E_p = 1588$ keV, 1599 keV, 1605 keV and 1620 keV. Branching ratios for resonance states and bound states in ^{61}Cu are reported. Gamma-ray distribution measurements were in agreement with the following spin and parity assignments for levels in ^{61}Cu: ground state, $3/2^-$; 475.8 keV, $1/2^-$; 970.2 keV, $5/2^-$; 1393.8 keV, $5/2^-$; 1660.5 keV $(3/2, 5/2)$; 2088.4 keV, $(1/2^-)$; 2207.0 keV, $(3/2, 5/2)$. The resonances $E_p = 1599$, 1605 and 1620 keV were concluded to be $J^\pi = 3/2$ states. Mixing ratios for secondary gamma rays are given. (auth) (Finland)

59765 ISOSPIN EFFECT IN $^{31}P(\gamma,n)$ REACTION. Mutsuro, Naoshi (Tohoku Univ., Sendai); Kawamura, Nobuaki; Tsubota, Hiroaki. Kakuriken Kenkyu Hokoku; 3: No. 1, 48-55(Oct 1970). (In Japanese).

The photoneutron spectrum of ^{31}P was measured by the time-of-flight method to obtain information concerning charge symmetry properties. The ^{31}P target was bombarded by bremsstrahlung having maximum energies of 21.5 and 25.5 MeV. The spectrum of (γ,p) taken by the Abe et al, was compared with the present result. The intensity of low energy part of the (γ,n) spectrum was smaller than that of the (γ,p) spectrum. Five structures within the scope of energy resolution were seen in both spectra. Widths of the fine structures were 50–150 keV and the separations were 100–300 keV. These results were examined with the statistical model. The experimental results were inconsistent with the theoretical results. The isospin effect was then introduced. It is concluded that $T = 3/2$ state plays a principal role in the (γ,n) reaction of ^{31}P from the consideration of gross and fine structures in the (γ,p) and (γ,n) spectra. Neutron decay from the $T = 3/2$ state was produced between states with best overlapping in balance of isospin part and other part of wave function. The fine structures of the spectra are forbidden (γ,n_0) transitions through isospin mixing. (Japan)

59766 ISOMER RATIOS FOR (n,2n) REACTIONS IN THE RANGE OF MASS NUMBERS BETWEEN 70 AND 90. **Bergmann, Helmar (Institut fuer Radiumforschung und Kernphysik, Vienna). Acta Phys. Austr.; 31: No. 4, 354-62(1970). (In German).**

The isomer ratio for the (n,2n) reaction was experimentally determined on target nuclei of ^{70}Zn, ^{76}Ge, and ^{82}Se with a neutron energy of (14.7 ± 0.15) MeV. For the calculation of the isomer ratio, two methods were utilized to obtain theoretical data for mass numbers between 70 and 90. With a mathematical procedure of Uhl, which is based on the statistical theory of nuclear reactions, satisfactory agreement was obtained between experimental and theoretical isomer ratios. Neither one of the two mathematical methods, however, was able to yield the parameter for spin distribution. (tr-auth)

59767 EVIDENCE FOR NEGATIVE PARITY ROTATIONAL BANDS IN ^{24}Mg. **Branford, D.; Gardner, N.; Wright, I. F. (Univ., Manchester, Eng.).** Phys. Lett.; 36B: No. 5, 456-8 (4 Oct 1971).

From a study of the ^{12}C(^{16}O,α)^{24}Mg reaction six ^{24}Mg levels have been ascribed to two rotational bands with $K^{\pi} = 0^-$ and $K^{\pi} = 3^-$. (auth)

59768 CROSS SECTIONS FOR ^{89}Y(n,n′)^{89m}Y AND ^{89}Y(n,2n)^{88}Y REACTIONS. Abboud, A. (Inst. of Nuclear Research, Warsaw); Decowski, P.; Grochulski, W.; (and others). Acta Phys. Pol.; B2: No. 4, 527-33(Jul-Aug 1971).

Excitation curves for the ^{89}Y(n,n′)^{89m}Y reaction were measured in the neutron energy range 3 to 18 MeV and for the ^{89}Y(n,2n)^{88}Y reaction in the energy range 13 to 18 MeV. The results obtained were interpreted in terms of the statistical nuclear reaction model. The problem of the competition between electromagnetic-radiation emission and neutron emission from the highly excited compound-nucleus states is discussed. (auth)

59769 OPTICAL MODEL ANALYSIS OF ^{3}He ELASTIC SCATTERING FROM NEIGHBORING EVEN AND ODD MASS NUCLEI. **Siegel, Graham Roger. St. Louis; Washington Univ. (1971). 200p. University Microfilms Order No. 71-19,831.**

Thesis.

Measured differential cross sections for the elastic scattering of ^{3}He ions are reported for angles between 6° and 168° for the following energies and targets: (30 MeV) ^{48}Ti, ^{51}V, ^{52}Cr, ^{60}Ni, ^{63}Cu, and ^{64}Zn; (32 MeV) ^{48}Ti, ^{51}V, ^{52}Cr, and ^{53}Cr; and (29 and 35 MeV) ^{51}V. The data are compared with optimum nuclear-optical-model predictions that were calculated using least-squares automatic-search computer programs. Ambiguities of the potential parameters of the model are studied in detail, with the result that, although both discrete and continuous ambiguities are present, the scattering does define rms radii for both the real and the imaginary parts of the potential. Furthermore, fits obtained with surface-peaked absorption potentials are consistently better than those obtained with volume absorption potentials. In all cases the inclusion of a spin–orbit potential significantly improves the optical-model fit to the data. The "best-fit" values of the spin–orbit potential depth were found to be between 1.2 and 3.8 MeV for most cases. No unambiguous target-spin effects were observed, but the average of the spin–orbit potential depths for odd-mass nuclei was always greater than that for the even-mass nuclei. A coupling between the spin–orbit and absorption potentials makes deductions based on small differences in the spin-orbit well depths inconclusive. A brief description of the experimental method is given, along with details of the experimental equipment and procedures. The preliminary analysis of the data, where measured elastic scattering yields were converted to center-of-mass differential cross sections, is also described. Mathematical derivations of some of the equations used in the optical model analysis are given. Finally, computer programs written for this study and the experimental differential cross sections are listed. (Diss. Abstr. Int., B.)

59770 INELASTIC SCATTERING OF 8.0 TO 9.0 MeV NEUTRONS BY ^{24}Mg, ^{27}Al, ^{28}Si, ^{31}P, AND ^{32}S. **Mittler, Arthur. Lexington, Ky.; Univ. of Kentucky (1970).** 142p. University Microfilms Order No. 71-19,382.

Thesis.

Measurements were made of the differential elastic and inelastic cross sections for neutrons scattered by silicon at 7.71 MeV; magnesium at 7.97 MeV; and aluminum, silicon, phosphorus, and sulfur at 7.96 and 9.05 MeV. Natural scattering samples were used. A neutron time-of-flight system was employed. The normalization for the measured differential cross sections was determined by making comparisons with neutron–proton scattering. Finite sample corrections were made for the elastic scattering data. The elastic cross sections have rms relative and absolute uncertainties of 2 to 5 and 6 to 8 per cent, respectively. The inelastic cross sections have rms relative and absolute uncertainties of 3 to 7 and 6 to 10 per cent, respectively. All measured elastic cross sections were compared to theoretical calculations obtained by adding the shape elastic contribution from the optical model to the compound elastic contribution from the statistical model. Theoretical calculations of the inelastic scattering from the first excited levels of ^{28}Si and ^{32}S were made by summing the statistical and direct-interaction predictions. The measurements agree with the models for ^{32}S. For ^{28}Si, only the 9.05-MeV measurements were in agreement with the models. The particle–core coupling model was used to compute the direct-interaction contributions to the inelastic cross sections of the low-lying levels of ^{27}Al and ^{31}P. The theoretical predictions are in agreement with the ^{31}P measurements but fail to describe the ^{27}Al measurements. (Diss. Abstr. Int., B)

59771 EXPERIMENTAL STUDY OF γ-RAY TRANSITION PROBABILITIES WITH THE RECOIL-DISTANCE AND THE DELAYED-COINCIDENCE TECHNIQUES. Henson, Sylvestus Hyatte. Stony Brook, N. Y.; State Univ. of New York (1970). 164p. University Microfilms Order No. 71-17,174.

Thesis.

The plunger and delayed-coincidence techniques were developed for use with the high-energy charged-particle beams from an FN tandem accelerator. By means of the plunger technique the lifetimes of the 1.974-MeV and 1.453-MeV states in ^{30}P were found to be 6.8 ± 0.4 psec and 9.2 ± 0.5 psec, respectively. A value of 10.7 ± 1 psec was obtained for the mean life of the 3.86-MeV state in ^{13}C. A charged-particle–γ technique was used to measure the lifetime of the 2.13-MeV state in ^{40}Ar. The value obtained was 150 ± 20 psec. Upper lifetime limits of 166 psec and 121 psec were obtained for the 780-keV level in ^{27}Si and the 2.80-MeV level in ^{39}Ca, respectively. A neutron–γ technique was successfully employed to clarify two previous measurements that were inconsistent in regard to the lifetime of the 287-keV state in ^{75}Se. (Diss. Abstr. Int., B.)

59772 DETERMINATION OF PHOTONUCLEAR REACTION CROSS SECTIONS. **Tikhonov, A. N.; Shevchenko, V. G.; Galkin, V. Ya.; (and others). Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 11: No. 2, 208-14(Mar-Apr 1970). (In Russian).**

An operative system for the automatic handling of data is described for the determination of photonuclear reaction cross sections with a 35-MeV betatron. The system provides for fully automatic processing of experimental data as accumulated in the analyzer all the way to obtaining the cross section of a photonuclear reaction. Bremsstrahlung which is generated at the target of the betatron passes through a collimator and then impinges on the desired material. The neutrons thus produced are recorded by a BF_3 detector using a paraffin moderator. The pulses are sent to the memory of a pulse-height analyzer. This system is illustrated with data from (γ,n) reactions with the nuclei ^{51}V, ^{59}Co, ^{58}Ni, and ^{60}Ni. (K.S.W.)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 57504, 57796, 59248, 59278, 59642, 59692, 59693, 59697, 59740, 59754, 59771, 59780, 59849, 59858, 59867, and 59868.

59773 (AD–721481) ISIS: A PROGRAM FOR COMPUTERIZED FISSION DATA ANALYSIS. **Alexander, Peter; Lightbody, David; Hansen, Carl; Patton, Waldo A. (Teledyne Isotopes, Westwood, N. J. Columbia Univ., New York). 30 Nov 1970. Contract DASA01-69-C-0057. 103p. (IWL–7909-217). NTIS.**

A two part computer program has been written to aid in the analysis and interpretation of experimental fission data. The first part of the program calculates the population of all members of any radioactive decay chain at any point in time using as input the initial population distribution and the structure of the decay chain. The program may also be used to perform a time integration of the population for any member to give the number of decays during a specified time interval. The second part of the program uses as input the experimentally measured yield values derived from extraction at various times after fission of one or more members of a particular fission product decay chain. The independent fission yield to any given mass chain is assumed to be distributed according to a Gaussian function. The parameters Z sub P and w characterizing this distribution are varied so as to minimize the quantity Chi squared which is based on the difference between the calculated and experimentally determined fission yield values. (auth)

59774 (AERE-Trans–1139) SUPERHEAVY ELEMENTS: EXTENSION OF THE PERIODIC SYSTEM. **Greiner, W. Trans-**

lated by J. B. Sykes, J. B. (Atomic Energy Research Establishment, Harwell, Eng.), from Umsch. Wiss. Tech.; 69: No. 12, 365-72(1969). 16p. Dep. NTIS (U. S. Sales Only). UK 15p.

In the periodic system the elements are arranged according to the number of their nuclear protons; the system extends from hydrogen as the lightest element, with one proton, to uranium, with 92 protons. During the last 30 years it has been possible to produce heavier elements (the transuranics) artificially. So far elements up to one with 104 protons, kurchatovium, have been reached. These elements are highly unstable, however, and immediately decay. According to present theory, stability will reappear only with very much heavier nuclei. It is hoped that the production of these superheavy elements will be possible in the foreseeable future. Their investigation will open up entirely new territory. (auth)

59775 (AWRE-O-44/71) EVALUATION OF $\bar{\nu}$ FOR ^{238}U. Mather, D. S.; Bampton, P. F. (Atomic Weapons Research Establishment, Aldermaston (England)). Jul 1971. 17p. Dep. NTIS (U. S. Sales Only). UK 15p.

An evaluation was made of direct measurements of $\bar{\nu}$ for the neutron-induced fission of ^{238}U using data available up to December 1970. A set of three straight lines is found to give the best representation of the variation of $\bar{\nu}$ with neutron energy and values specifying this evaluation were produced for entry in a new Data File DFN-272. (auth)

59776 (FRNC-TH-56) DETERMINATION OF ELECTROMAGNETIC TRANSITION PROBABILITIES FROM MEASUREMENTS OF THE MEAN LIVES OF EXCITED NUCLEAR STATES; APPLICATION TO ^{140}Ce, ^{191}Pt, AND ^{135}La NUCLEI. Bourgeois, Christian (Paris Univ., Orsay (France)). 1971. 67p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A system was developed for rapidly detecting gamma–gamma coincidences. This system was used in conjunction with a double focusing magnetic spectrometer in order to make electron–electron or electron–gamma coincidence measurements. The assembly was used to measure the mean lives of nuclear levels ranging from some tens of picoseconds up to a few microseconds. Studies of the excited states of the ^{191}Pt, ^{140}Ce and ^{135}La nuclei allowed the theoretical models proposed for the three different cases to be tested, and an estimation to be made of the form of the potential associated with each of these nuclei in the energy states considered. (France)

59777 (IFA-NR-33) ABSOLUTE MEASUREMENT OF ^{239}Pu FISSION CROSS-SECTION FOR 2200 m/sec NEUTRONS. Borcea, C.; Borza, A.; Buta, A.; Isbasescu, A.; Marinescu, L.; Mihai, I.; Nascutiu, T.; Petrascu, M.; Savu, V.; Simion, V. (Institutul de Fizica Atomica, Bucharest (Romania)). 1970. 29p. Dep. NTIS (U. S. Sales Only).

The absolute fission cross section σ_f for ^{239}Pu was measured by means of a method requiring no knowledge of an intermediate cross section for the neutron flux determination. The principle of the method and the apparatus used are described. The final result is 741.0 ± 7.0 barns. (R.W.R.)

59778 (JAERI-Memo-4520) ^{208}Pb(γ,n)^{207}Pb REACTION NEAR THRESHOLD. Mizumoto, M.; Nakajima, Y.; Bergere, R.; Fuketa, T. (Japan Atomic Energy Research Inst., Tokyo). Jul 1971. 17p. Dep. NTIS (U. S. Sales Only).

The photoneutron cross section for ^{208}Pb was studied at several hundred keV neutron energy by the neutron time-of-flight technique. Spins and parities of the compound levels were determined by measuring the angular distribution of emitted neutrons, and the ratios of reaction matrix elements for channel spin 1 and 0 were calculated for the excited states of 1^+ of ^{208}Pb. (auth)

59779 (JINR-P-7-5912) INVESTIGATION OF THE PRODUCTION AND DECAY OF COMPOUND NUCLEI IN THE HIGH-ENERGY HEAVY ION REACTIONS. Oganesian, Yu. Ts.; Penionzhkevich, Yu. E.; Shamsutdinov, A. O.; Ngyuen, Tak An. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 15p. (In Russian). Dep. NTIS (U. S. Sales Only).

The results of measurements of the excitation functions are given for the following reactions: ^{130}Te(^{12}C,xn)$^{142-x}$Ce, ^{130}Te(^{13}C,xn)$^{143-x}$Ce(x = 3–12), ^{130}Te(^{12}C,αxn)$^{138-x}$Ba, ^{130}Te(^{13}C,αxn)$^{138-x}$Ba(x = 4–10), at a carbon ion energy of more than 10 MeV/nucl. The dependence of the production cross section of a compound nucleus on the energy of the bombarding ion is measured. This cross section value is shown to decrease essentially with the increasing energy of the bombarding particle. The estimate of the critical value for the angular momentum is given. The energy dependence of the ratio between the evaporation cross section of α-particles and the neutron evaporation cross section is determined. (auth)

59780 (KFK-1401) MEASUREMENT OF THE CIRCULAR POLARIZATION OF γ RADIATION AFTER CAPTURE OF POLARIZED THERMAL NEUTRONS IN NUCLEI. Djadali, Fayegh (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jun 1971. 49p. (In German). Dep. NTIS (U. S. Sales Only).

The circular polarization of γ radiation from nuclei after capture of polarized thermal neutrons was measured using Ge(Li) and NaI(Tl) detectors. The Karlsruhe research reactor FR2 was used as a neutron source. The flux was 6×10^6 nsec^{-1} at the target. Reflection from a Co–Fe mirror of 1 m length provided a polarization of 66%. Natural targets of S, Cl, Y, K, Ce, Nd, and La were exposed to this beam. From the measurement of the circular polarization of high-energy capture γ rays several spin values were newly established or confirmed. The E2/M1 mixing ratio of the 8.58-MeV transition in Cl was obtained. The circular polarization averaged over the γ spectrum after capture of polarized thermal neutrons was measured for some nuclei. Conclusions on the spin of the compound state are drawn. Natural targets of Mo, Cd, In, Sb, I, Cs, Pr, Gd, Tb, Ho, Ta, Hg, and La were used. (R.W.R.)

59781 (KURRI-TR-76, pp 19-20) EXPERIMENT ON SHORT LIVED NUCLEI. Katoh, Toshio (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on nuclei with short life; Osaka, Japan (30 Jun 1969).

In Reports of the study meeting on nuclei with short life.

Short-lived nuclei were produced by (n,p) reaction, and gamma radiation from the nuclei was observed with a Ge(Li) semiconductor detector. Merits of the (n,p) reaction for the production of the short-lived nuclei are production of nuclei which cannot be made by any other methods and possibility of experiment with small funding and a small size neutron generator. Irradiation of samples was performed outside the neutron generator and without cooling, because conditions of sample preparation and neutron irradiation were not severe. Gamma-ray spectra were measured just after the irradiation. The cross-section of the (n,p) reaction, however, is small, and the irradiation was repeated many times. Sample of enriched ^{174}Yb was irradiated with fast-neutron flux of 7×10^7 cm$^{-2}\cdot$sec^{-1}, and sent to a counting room by a pneumatic tube system. Gamma rays from ^{174}Tm, made by the reaction ^{174}Yb(n,p)^{174}Tm, were observed with a Ge(Li) detector. The half-life was measured to be 5.5 min. The irradiation was repeated 176 times, and data were accumulated. Observed spectra and a proposed decay scheme are shown in figures. Experiments on ^{94}Y, ^{98}Nb, ^{178}Lu, and ^{186}Ta are planned. (Japan)

59782 (KURRI-TR-76, pp 21-6) MEASUREMENT FOR SHORT LIVED NUCLEI. Okano, Kotoyuki (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on nuclei with short life; Osaka, Japan (30 Jun 1969).

In Reports of the study meeting on nuclei with short life.

Outline of studies on short-lived nuclei produced with reactors and hilacs is presented. The short-lived nuclei of Xe and Ba were studied at Cornell University with a TRIGA type reactor. Pulsed neutron beam with width of 35 msec was produced in the reactor, and the flux was 2×10^{15} n/cm$^2\cdot$sec. Irradiated samples were sent to a counting station by a pneumatic tube system within 50 to 150 msec. Polyethylene capsules were broken with an injection needle, and Xe gas was collected on top of a cold trap. Measurement of gamma rays with a Ge(Li) semiconductor or a NaI(Tl) scintillation detector was performed automatically. On the other hand, rapid chemical separation was employed for the other case. A gas-phase separation method was applied for separation of ^{90}Rb. Uranium stearate sample was irradiated with neutrons. Halogens were removed with a glass-wool trap and xenon gas was removed with a charcoal trap. Rubidium ions produced by decaying Kr gas were collected on an aluminum foil, and gamma rays and beta rays were detected with scintillation counters. A mass separator was also used to obtain Xe gas; and a hilac, to study Th isotopes produced by heavy ion bombardment. A semi on-line irradiation system was designed at Research Reactor Institute of Kyoto University (KUR). A pneumatic tube was set in the reactor of KUR. Measurement and irradiation can be repeated automatically. Transportation time for samples is about 0.3 sec. Studies of ^{104}Rh ($T_{½}$ = 43 sec) and ^{108}Ag (2.42 min) were carried out. (Japan)

59783 (UCRL-50400(Vol.4)) EVALUATED NUCLEAR CROSS SECTION LIBRARY. Howerton, R. J.; Doyas, R. J.; Michels, T. C.; Perkins, S. T. (California Univ., Livermore. Lawrence Radiation Lab.). 15 Apr 1971. 171p. Dep. NTIS.

The LRL collection of evaluated data for neutron-, photon-, and charged- particle-induced reactions is maintained in a computer-oriented system. This system, with its history, methods of evaluation, and examples of input and output representation of the data, is described.

59784 (UCRL–73336) THRESHOLD PHOTONEUTRONS AND PHOTON DOORWAYS. Berman, B. L.; Bowman, C. D.; Baglan, R. J. (California Univ., Livermore. Lawrence Radiation Lab.). 5 Aug 1971. 7p. (CONF-710814–1). Dep. NTIS.

From International conference on statistical properties of nuclei; Albany, N. Y. (22 Aug 1971).

A review is given of work on threshold photoneutron cross sections and photon doorway states. The threshold photoneutron cross sections were measured for 16 nuclei, and over 250 resonances were identified and in most cases parametrized. (J.F.P.)

59785 TABLITSA ENERGII GAMMA-LUCHEI VOZNIKAYUSHCHIKH PRI RASPADE RADIOAKTIVNYKH YADER. (Energy Tables for Gamma Ray Emission During Radioactive Decay). Dzhelepov, B. S.; Koksharova, S. F. Leningrad; Izdatel'stvo Nauka (1970). 288p.

Tables are presented of the energy of gamma radiation arising through decay of radioactive nuclides with half-lives greater than one second. The energy values of gamma radiation are arranged in ascending order, and are accompanied by a list of the nuclei which emit the quanta indicated. An extensive bibliography is appended which includes Russian and foreign literature up to October, 1969, and which contains experimental data on gamma ray energies which were evaluated for this compilation. 500 references. (tr-auth)

59786 PHOTOFISSION OF ^{232}Th NEAR THRESHOLD: ANGULAR DISTRIBUTION. Manfredini, A. (Istituto Nazionale di Fisica Nucleare, Messina, Italy. Univ., Messina, Italy); Fiore, L.; Ramorino, C.; Woelfli, W. Nuovo Cim.; 4A: No. 2, 421-30 (21 Jul 1971).

Measurements on the angular distribution of photofission fragments of ^{232}Th from monochromatic γ-rays at energies near threshold are reported. The data are compared with measurements of other authors obtained with a bremsstrahlung γ-ray source. (auth)

59787 SCREENING EFFECTS ON INTERNAL CONVERSION FROM OUTER ATOMIC SHELLS. Trusov, V. F. (Latvian State Univ., Riga). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 11, 150-3(1970). (In Russian).

Coefficients of internal conversion of γ radiation were computed for the N and O shells of mercury by using two screening potentials. Values are given for radial wave functions for various subshells. Testing the ratios M_1/N_1, M_1/O_1 and N_1/O_1 shows that, for coefficients of internal conversion, these ratios are very close (1%) to the ratios of the electron density for all observed energies. Results are found to agree with experimentally obtained values for the E-2 transition (158 keV) for ^{199}Hg (O. Dragoun, P. Jahn et al., Phys. Lett., B28: No. 4, 251(1968)): $N_{II}/N_I = 7.7 \pm 2.4$ and $N_{II}/N_{III} = 1.37 \pm 0.10$. (K.S.W.)

59788 ELASTIC SCATTERING OF 5- TO 10-MeV PROTONS FROM ALIGNED ^{165}Ho. Fisher, T. R. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.); Tabor, S. L.; Watson, B. A. Phys. Rev. Lett.; 27: No. 16, 1078-80(18 Oct 1971).

The scattering of protons from an aligned ^{165}Ho target $[B_2/B_2(\max) = -0.34]$ is analyzed to obtain an estimate of the nuclear quadrupole moment or, equivalently, the nuclear deformation parameter β. The data are in reasonable agreement with the result, $\beta = 0.33$, derived from Coulomb excitation measurements. (auth)

59789 NEW (p,n) REACTION STUDIES AT $E_p = 23$ MeV. Bentley, R. F.; Carlson, J. D.; Lind, D. A.; Perkins, R. B.; Zafiratos, C. D. (Univ. of Colorado, Boulder). Phys. Rev. Lett.; 27: No. 16, 1081-3(18 Oct 1971).

The (p,n) reaction was studied at $E_p = 23$ MeV on 35 nuclei ranging in mass from ^{9}Be to ^{208}Pb. Overall energy resolution for the levels of interest ranged from 50 to 200 keV. Compound-nucleus contributions appear to be generally small at this bombarding energy. Early distorted-wave Born-approximation analysis of the data reveals several difficulties, both for macroscopic and microscopic forms of analysis. (auth)

59790 EXPERIMENTAL MEASUREMENT OF THE K-CONVERSION COEFFICIENT OF 80 keV TRANSITION IN ^{144}Pr. Sahota, H. S. (Punjab Univ., Patiala, India). Curr. Sci. (India); 40: No. 11, 289-90(5 Jun 1971).

The gamma intensity of the 80-keV transition in ^{144}Pr was measured relative to that of the 133-keV transition by using a 2.5-cm^3 Ge(Li) detector. The final result, $\alpha_K = 2.09 \pm 0.16$, agrees with the theoretical value. (R.W.R.)

59791 NUCLEAR CHARGE DISTRIBUTIONS OF ^{89}Y, ^{90}Zr, AND ^{92}Mo BY ELASTIC ELECTRON SCATTERING. Singhal, R. P. (Univ. of Glasgow). J. Phys., A (London); 4: No. 5, L93-7(Sep 1971).

Elastic scattering of electrons was used to extract the nuclear charge distribution parameters of the N = 50 isotones ^{89}Y, ^{90}Zr and ^{92}Mo. The momentum transfer range studied is from 0.25 fm^{-1} to 1.15 fm^{-1}. A comparison of the differences in the charge distributions is made with the shell model predictions. (auth)

59792 K- AND L-SHELL ELECTRON SHAKE-OFF IN THE BETA DECAY OF ^{204}Tl. Howard, J. M.; Seykora, E. J.; Waltner, A. W. (North Carolina State Univ., Raleigh). Phys. Rev., A; 4: No. 5, 1740-5(Nov 1971).

Electron shake-off has been investigated in the decay of ^{204}Tl in a measurement of the relative intensities of the Hg and Pb K and L x rays. Values of $(1.0 \pm 0.1) \times 10^{-2}\%$ and $(20.0 \pm 2.0) \times 10^{-2}\%$ have been obtained for the K-shell and total L-shell electron shake-off probabilities, respectively. Approximations of individual L-subshell shake-off probabilities resulted in values of $(2.0 \pm 0.6) \times 10^{-2}\%$, $(9.3 \pm 0.6) \times 10^{-2}\%$, and $(9.0 \pm 0.6) \times 10^{-2}\%$ for the L_I, L_{II}, and L_{III} subshells, respectively. These values, in some cases, differ by as much as a factor of 3 from theoretical predictions. (auth)

59793 NUCLEAR CHARGE DISTRIBUTIONS FROM ELECTRON SCATTERING: BARIUM AND NEODYMIUM. Heisenberg, J. (Stanford Univ., Calif.); Hofstadter, R.; McCarthy, J. S.; (and others). Contract NONR-225(67). pp 169-189 of Topics in Modern Physics. /Brittin, Wesley E. (ed.). Boulder, Colo.; Colorado Associated Univ. Press (1971).

Over the last few years, the authors have performed detailed explorations of nuclear charge distributions of the calcium isotopes and lead, ^{208}Pb. With these doubly magic nuclei, precise measurements of differential cross sections have led to information concerning the behavior of the charge distribution in the central regions of the nuclei and at the extreme edge. Since these two elements, calcium and lead, at opposite ends of the periodic table, show similar characteristics, intermediate nuclei ^{138}Ba and ^{142}Nd were examined. Experimental differential cross sections for electron scattering by ^{138}Ba at 500 and 200 MeV and for ^{142}Nd at 129.4, 199.3, 299.1 and 499.5 MeV are presented. The experimental values, along with a least-squares analysis of the data allow parameters to be determined for the nuclear charge distributions. The distributions are also compared with information obtained from muonic x rays and low-energy electron scattering. The results are then related to the earlier work on calcium and lead and compared with various nuclear models. (L.M.T.)

59794 NUCLEAR PHOTOFISSION CROSS SECTIONS FOR THE PHOTON ENERGIES UP TO 5 GeV. SUPERGIANT RESONANCE IN THE PHOTONUCLEI REACTIONS. Vartapetyan, G. A.; Demekhina, N. A.; Kasilov, V. I.; (and others) (Physical-Technical Inst., Kazan). Yadern. Fiz.; 14: No. 1, 65-72(Jul 1971). (In Russian).

Photofission yields for the nuclei ^{238}U, ^{235}U, ^{232}Th, ^{209}Bi, ^{197}Au, and ^{181}Ta in the photon energy interval from 100 MeV up to 5 GeV are measured by means of the glass detectors. The measured results are in satisfactory agreement with the yields calculated on basis of the photomeson fission model. In the fission cross sections of U and Th besides the giant resonance there is a resonance at the photon energy $E \sim 300$ MeV corresponding to the resonances in the photon–nucleon interaction cross section. The integral photofission cross sections are presented. (auth)

59795 BETA–GAMMA DIRECTIONAL CORRELATION OF ^{203}Hg. Wyrick, John M. St. Louis; St. Louis Univ. (1970). 203p. University Microfilms Order No. 71-21,434.

Thesis.

The beta–gamma directional correlation of ^{203}Hg was measured for the beta energies 80, 100, 130, and 160 keV. The 279-keV gamma rays following the 207-keV beta decay were measured in coincidence with beta rays of the energies mentioned above. The objective of this experiment was to determine whether or not the "ξ-approximation" is valid for the first-forbidden beta decay of ^{203}Hg. The final experimental results indicate values for the $A_2(\beta)$ beta directional correlation coefficients that agree with the magnitude of these values as predicted in the ξ-approximation. A survey of beta–gamma directional correlation theory is given with emphasis on experimental applications. Also included is a discussion of the apparatus and experimental techniques used in the ^{203}Hg measurements. (Diss. Abstr. Int., B)

59796 ELASTIC ELECTRON SCATTERING FROM ORIENTED ^{165}Ho NUCLEI. Uhrhane, Francis Joseph. Stanford, Calif.; Stanford Univ. (1971). 137p. University Microfilms Order No. 71-19,772.

Thesis.

The determination of the distribution of electric charge in the

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highly deformed nucleus of ^{165}Ho is considered. High-energy electron scattering is used to examine the nuclear charge distribution. Nuclear orientation is required in order to measure the effect of a distorted nucleus on the scattering cross section. The orientation is accomplished by the so-called "static" method maintaining the ^{165}Ho sample at 0.4°K and applying a magnetic field. Corrections to the raw experimental data are explained, and the final experimental results are presented. The results include cross sections for electron scattering at a polar angle of 36° from randomly oriented nuclei and from aligned nuclei at seventeen incident beam energies ranging from 160.6 MeV to 452.2 MeV. One theory for scattering from randomly oriented nuclei is found to provide a reasonable fit to the data but to give little new information about the nucleus. The alignment effect measured has features in qualitative agreement with available theoretical calculations, but has essentially no quantitative agreement. Assumptions of the theories in contradiction to the experimental conditions are pointed out. (TSS)

59797 EXCITATION OF ISOMERIC ACTIVITIES OF Rb, Y, Pd, Cd, W, Os, AND Pb USING 14.8-MeV NEUTRONS. Rurarz, E.; Chwaszczewska, J.; Haratym, Z.; Pietrzykowski, M.; Sulik, A. (Inst. of Nuclear Research, Swierk, Poland). Acta Phys. Pol.; B2: No. 4, 553-64(Jul-Aug 1971).

Activation cross sections of ^{84m}Rb, ^{86m}Rb, ^{89m}Y, ^{107m}Pd, ^{109m}Pd, ^{111m}Cd, ^{185m}W, ^{190m}Os, and ^{203}Pb for 14.8-MeV neutrons were measured using Ge(Li) and NaI(Tl) detectors. The following values (in millibarns) were obtained: ^{85}Rb(n,2n)^{84m}Rb (20.5 min), 412 ± 40; ^{87}Rb(n,2n)^{86m}Rb (1 min), 432 ± 45; ^{89}Y(n,n′γ)^{89m}Y (16.5s), 438 ± 44; ^{108}Pd(n,2n)^{107m}Pd (21s), 590 ± 60; ^{110}Pd(n,2n)^{109m}Pd (4.8 min), 554 ± 55; ^{112}Cd(n,2n)^{111m}Cd (48 min), 812 ± 80; ^{111}Cd(n,n′γ)^{111m}Cd (48 min), 167 ± 17; ^{186}W(n,2n)^{185m}W (1.7 min), 1152 ± 110; ^{190}Os(n,n′γ)^{190m}Os (10 min), 15 ± 1.5; and ^{204}Pb(n,2n)^{203m}Pb (6.1s), 1020 ± 100. Experimental results for isomeric ratios in (n,2n) reactions are compared with statistical-theory predictions. (auth)

59798 DECAY SCHEME OF ^{232}Pa. Kaczarowski, R.; Kurcewicz, W.; Plochocki, A.; Zylicz, J. (Inst. of Nuclear Research, Swierk, Poland). Acta Phys. Pol.; B2: No. 4, 423-39(Jul-Aug 1971).

Magnetic and semiconductor (Ge and Si) spectrometers were used to study the ^{232}Pa → ^{232}U decay scheme. The following γ lines, new with respect to the earlier data reported by Bjoernholm et al., [Nucl. Phys., 42: 469(1963)] were observed: 922.7, 1003.3, 1016.4, 1051.4, 1055.4, 1085.4, 1125.1, 1132.7, and 1164.5 keV. Conversion coefficients and multipolarity assignments were determined for several of these transitions. Due to the e−γ coincidence studies it was possible to show that the 1125.1- and 1055.4-keV E1 transitions feed, respectively, the 2^+ and 4^+ levels of ^{232}U ground-state band. This indicates the existence of the new ^{232}U levels at 1172.8 and 1212.1 keV, which are interpreted as 2^- and 3^- members of the $K^\pi = 1^-$ octupole band. Another new level is proposed at 1132.9 keV. The 1016.4-keV M2 transition is believed to connect the bandhead state of the $K^\pi = 2^-$ octupole band with the ground state; the 1051.4-keV transition may possibly be an analogous E3 transition from the 3^- state of this band. As deduced from the β−γ coincidence experiments, the β^- decay energy of ^{232}Pa is equal to 1337 ± 10 keV. The discussion of experimental data in terms of nuclear models is concentrated on the octupole bands and their Coriolis interaction. (auth)

59799 RELATIVE K-CAPTURE PROBABILITY IN UNIQUE FIRST-FORBIDDEN DECAY OF ^{145}Sm. Myslek, B.; Pietrzyk, B.; Sujkowski, Z.; Szczepanikowski, J. (Inst. of Nuclear Research, Swierk, Poland). Acta Phys. Pol.; B2: No. 4, 441-50 (Jul-Aug 1971).

The relative K-capture probability, P_K, for the unique first-forbidden decay of ^{145}Sm to the 492.3-keV level in ^{145}Pm was measured by the coincidence method to be $P_K = 0.27 \pm 0.03$. This is compared with the theoretical values P_K(allowed) = 0.70 ± 0.03 and P_K(unique forb.) = $0.19^{+0.06}_{-0.05}$ calculated using the experimental decay energy Q = 115 ± 10 keV. (auth)

59800 LEVELS OF ^{230}Th AND ^{230}U FED IN DECAY OF ^{230}Pa. Kurcewicz, W. (Inst. of Nuclear Research, Swierk, Poland); Stryczniewicz, K.; Zylicz, J.; (and others). Acta Phys. Pol.; B2: No. 4, 451-71(Jul-Aug 1971).

The ^{230}Pa decay to levels of ^{230}Th and ^{230}U is investigated by using Si(Li) and Ge(Li) spectrometers for singles-spectra measurements, and a Ge(Li) spectrometer combined with a six-gap β spectrometer or with a NaI(Tl) detector for coincidence measurements. The decay scheme is proposed which accounts for all but one of the 50 transitions observed in the present investigation. The following bands of the ^{230}Th excited states are established or proposed (in parentheses: level energies in keV, spin values and parities of the levels): the ground-state band (53.19, 2^+ and 174.12, 4^+), the quadrupole bands (β: 634.7, 0^+ and 677.8, 2^+; γ: 781.4, 2^+ and 825.4, 3^+; β + γ (?): 1009.61, 2^+ and 1052.6, 3^+) and the octupole bands ($K^\pi = 0^-$: 508.20, 1^- and 571.71, 3^-; $K^\pi = 1^-$: 951.91, 1^-; 971.70, 2^-; and 1012.2, 3^-; $K^\pi = 2^-$: 1079.20, 2^- and 1127.85, 3^-). The ^{230}Pa → ^{230}Th decay energy, Q, is deduced from the measured relative probabilities of the K-capture transitions to several excited states in ^{230}Th: Q = 1315^{+15}_{-10} keV. For ^{230}U, the first excited 2^+ state is observed at 51.72 keV, and the bandhead state of the $K^\pi = 0^-$ octupole band is proposed at 366.5 keV. The experimental data are discussed in terms of nuclear models, with emphasis on the band-mixing effects. (auth)

59801 MEASUREMENT OF γ-RAY SPECTRA ACCOMPANYING RADIATIVE CAPTURE OF NUCLEONS. Brzosko, J. S.; Gierlik, E.; Soltan, A. Jr.; Szeflinski, Z.; Wilhelmi, Z. (Univ., Warsaw). Acta Phys. Pol.; B2: No. 4, 489-502(Jul-Aug 1971).

Spectra of photons from the (n,γ) reaction were measured for ^{115}In, Sb, ^{127}I, ^{133}Cs, ^{159}Tb, ^{165}Ho, ^{181}Ta, ^{197}Au, Tl, and ^{238}U nuclei at neutron energies of about 400 keV. The dependence of the cross sections for high-energy γ-ray emission on neutron energy in the range 0.03 to 1.4 MeV was investigated for ^{115}In, ^{181}Ta, and ^{197}Au. Furthermore, γ-ray spectra for the (p,γ) reaction were measured and compared with those for the (n,γ) reaction. The experimental results are compared with the results of calculation based on the compound-nucleus model under the assumption that the probability of emission of γ rays with energy of about 6 MeV is increased. (auth)

59802 (n,α) REACTIONS ON HEAVY NUCLEI INDUCED BY 14.2-MeV NEUTRONS. Jaskola, M. (Inst. of Nuclear Research, Swierk, Poland); Turkiewicz, J.; Zemlo, L.; Osakiewicz, W. Acta Phys. Pol.; B2: No. 4, 521-6(Jul-Aug 1971).

The energy spectra of alpha particles from (n,α) reactions with ^{122}Te, ^{139}La, ^{159}Tb, ^{160}Dy, ^{161}Dy, ^{163}Dy, ^{164}Dy, ^{166}Er, ^{168}Er, and ^{169}Tm induced by 14.2-MeV neutrons were measured using semiconductor detectors. The analysis of the energy spectra leads to results which imply that the evaporation theory is inadequate to describe the reactions investigated. The shapes of the experimental spectra suggest the presence of strong direct effects. (auth)

59803 THEORETICAL ESTIMATES OF LIFETIMES OF SUPERHEAVY NUCLEI. Lukasiak, A.; Sobiczewski, A.; Stepien-Rudzka, W. (Inst. of Nuclear Research, Warsaw). Acta Phys. Pol.; B2: No. 4, 535-52(Jul-Aug 1971).

The spontaneous-fission and alpha-decay half-lives of even superheavy nuclei are calculated microscopically. The calculations are based on the single-particle Nilsson scheme with the parameters fitted to the scheme obtained in the Woods−Saxon potential at zero deformation. The largest total half-lives of the order of 10^{10} years are obtained for the nuclei with Z = 108 to 110 and N = 184. The strength of the pairing forces used is smaller than in previous investigations. The use of a larger strength would lead to half-lives smaller by a few orders. The sensitivity of the half-lives to different factors, in particular to the strength of the pairing force, is discussed. (auth)

59804 COULOMB EXCITATION OF THE LEAD ISOTOPES WITH α AND ^{16}O BEAMS. Grosse, E.; Dost, M.; Haberkant, K.; (and others) (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys.; A174: No. 3, 525-38(1971).

The lead isotopes were Coulomb excited by α particles of 15 and 18 MeV and ^{16}O ions of 70 and 80 MeV. By measuring the absolute yields of the de-excitation γ rays very accurately, B(Eλ) values for the first 2^+ states in ^{204}Pb and ^{206}Pb, the 3^- states in ^{206}Pb and ^{208}Pb, and of four states in ^{207}Pb were obtained. The E2 transition strengths to the first two excited states of ^{207}Pb are well described by coupling these states to a quadrupole core excitation of ^{208}Pb. The B(E3) values for the excitation of the $(3^- \otimes p_{\frac{1}{2}})$ doublet show only slight deviations from the weak-coupling value; yet the lifetimes of the two states, which were determined with the Doppler shift-attenuation method, are different from model predictions. The M1 transition rate of the $\frac{3}{2}^-$ state to ground, as determined from the lifetime of 0.17 psec, agrees with the value obtained from the B(E2) and the mixing-ratio measurement. (auth)

59805 ENERGY LEVELS IN ^{191}Ir. Price, R. H.; Johns, M. W. (McMaster Univ., Hamilton, Ont.). Nucl. Phys.; A174: No. 3, 497-524(1971).

The electron-capture decay of ^{191}Pt was studied using Ge(Li) detectors singly and in coincidence to identify fifty-one transitions in ^{191}Ir. The energies and intensities of the internal conversion lines associated with eighteen of these transitions were determined and used to establish multipolarities and mixing ratios. Thirteen transitions were excited in Coulomb excitation using oxygen ions of energy ranging from 25 to 65 MeV, and B(E2)↑

values were determined for six excited states. The results of the measurements are embodied in a decay scheme involving levels in ^{191}Ir with energies (in keV), spins and parities as follows: $0(3/2^+)$, $82.398\ (1/2^+)$, $129.400(5/2^+)$, $171.32(11/2^-)$, $178.93(3/2^+)$, $343.2\ (7/2^+)$, $351.15(5/2^+)$, $390.97(7/2^-)$, $502.5(9/2^+)$, $538.85(3/2^+)$, $587.95(5/2^+)$, $624.06(1/2^+)$, $658.87(3/2^-)$, $686.3(7/2^+)$, $747.74(5/2^+)$, $762.56(3/2^+)$, $799.75\ (5/2^-)$, and $935.33(3/2^+?)$. (auth)

59806 PROMPT $\bar{\nu}$ IN SPONTANEOUS AND NEUTRON INDUCED FISSION OF ^{236}U AND ITS HALF-LIFE FOR SPONTANEOUS FISSION. Conde, H.; Holmberg, M. (Research Inst. of National Defence, Stockholm). J. Nucl. Energy; 25: No. 8, 331-8(Aug 1971).

The energy dependence of prompt $\bar{\nu}$ was investigated for the neutron induced fission of ^{236}U in the energy range 0.8–6.7 MeV. The fission neutron detector was a large liquid scintillator. The data could be fitted to a straight line $\bar{\nu}_p(E_n) = 2.316 + 0.131E_n$. Prompt $\bar{\nu}$ for the spontaneous fission of ^{236}U and ^{238}U were also measured with the result $\bar{\nu}_p(^{236}U) = 1.90 \pm 0.05$ and $\bar{\nu}_p(^{238}U) = 2.00 \pm 0.05$. The ratio between the half-lives for spontaneous fission of ^{238}U and ^{236}U was determined to be 0.30 ± 0.03. (auth)

59807 MEASUREMENTS OF NMR ON ORIENTED ^{192}Ir AND ^{191m}Ir IN Ni AND Fe HOST LATTICES. Eska, G. (Technische Univ., Munich); Hagn, E.; Butz, T.; Kienle, P.; Umlauf, E. Phys. Lett.; 36B: No. 4, 328-30(20 Sep 1971).

From the extrapolated zero-field resonance frequencies the g-factors of the ^{192}Ir ground state and the $11/2^-$ isomer state of ^{191}Ir are deduced to 0.4701 ± 0.0027 and 1.0957 ± 0.066, respectively. In addition spin-lattice relaxation times were measured. (auth)

59808 ISOVECTOR POTENTIAL IN ^{208}Pb FROM PARTIAL MUON CAPTURE. Bressani, T. (Univ., Turin. INFN, Turin); Molinari, A. Phys. Lett.; 36B: No. 4, 297-300(20 Sep 1971).

The strength of the isovector potential in ^{208}Pb is estimated using the hypothesis of a total inhibition of the partial μ^- capture in ^{208}Pb with excitation of giant resonance in ^{208}Tl. (J.W.R.)

59809 EXPLANATION FOR THE 0^+ EXCITED PAIRING STATE IN ACTINIDE NUCLEI. Griffin, R. E.; Jackson, A. D.; Volkov, A. B. (State Univ. of New York, Stony Brook). Phys. Lett.; 36B: No. 4, 281-6(20 Sep 1971).

The existence of more than one collective 0^+ state in deformed nuclei due to the separation of "oblate" and "prolate" matrix elements is demonstrated by means of a model calculation and calculations using ^{240}Pu single particle wave functions. (auth)

59810 ENERGY DEPENDENCE OF $\bar{\nu}_p$ FOR ^{233}U, ^{235}U, AND ^{239}Pu BELOW 5.0 MeV. Walsh, R. L.; Boldeman, J. W. (Australian Atomic Energy Commission Research Establishment, Sutherland). J. Nucl. Energy; 25: No. 8, 321-30(Aug 1971).

Measurements were made of the energy dependence of $\bar{\nu}_p$ for neutron induced fission of ^{233}U from thermal to 2.0 MeV. An analysis was made of all existing data below 5 MeV for ^{233}U, ^{235}U and ^{239}Pu. It was observed from this analysis that the energy dependence of $\bar{\nu}_p$ for all three nuclei may be characterized by a two line dependence in which the change of slope occurs at the pairing energy. The nature of the $\bar{\nu}_p(E_n)$ dependence is explained in terms of the double-humped fission barrier, and is consistent with the adiabatic assumption of weak coupling of the collective degrees of freedom at the saddle point to the nuclear degrees of freedom at scission. (auth)

59811 MEASUREMENTS OF THE TOTAL NEUTRON CROSS SECTION OF PRASEODYMIUM BETWEEN 1 AND 18 MeV. Enayetullah, M. (Atomic Energy Centre, Dacca, Pakistan); Ameen, N.; Islam, N.; (and others). Nucl. Sci. Eng.; 46: No. 1, 148-50(Oct 1971).

The transmission method was used for the measurement of the neutron total cross section of praseodymium at 1 to 18 MeV. The results were compared with optical model calculations. (J.W.R.)

59812 NEW DATA OF DIFFERENTIAL MEASUREMENTS OF RATIO α FOR ^{239}Pu. Sukhoruchkin, S. I. At. Energ. (USSR); 31: No. 3, 245-58(Sep 1971). (In Russian).

Results of measurements performed during 1968–1970 yrs of the ratio $\alpha = \sigma_c/\sigma_f$ for plutonium-239, with neutron energies up to 10 to 15 keV, are considered. A reduction in the dispersion of experimental results for this energy range is pointed out; possible ways of determining this important reactor constant with greater accuracy are discussed. (31 references) (auth)

59813 β AND γ ACTIVITY OF THE FISSION PRODUCTS OF ^{235}U AND ^{239}Pu. II. COMPARISON WITH THE EXPERIMENTAL RESULTS. Costa, L.; de Tourreil, R. (CEN, Fontenay-aux-Roses, France). J. Nucl. Energy; 25: No. 7, 285-95(Jul 1971). (In French).

A comparative study is made between the various experimental measurements concerning the decay rates, β and γ residual powers, and the theoretical computation based on the fission products properties in the most sensitive case of only one thermal fission of ^{235}U and ^{239}Pu. It is concluded that even for the "well known" ^{235}U case, the discrepancies between the different experimental results are much greater than the estimated errors, owing to the difficulty of normalizing the measurements. The computed results obtained from the fission products properties give an error of <30% for β and 15% for γ residual powers between $10^2 \leq \tau \leq 10^3$ sec cooling time and only a few per cent for β and γ residual powers for cooling time $\tau > 10^3$ sec. (auth) (UK)

59814 NUCLEAR REACTIONS INITIATED BY RECOIL NUCLEI. Kabir, P. K.; Trefil, J. S. (Univ. of Virginia, Charlottesville). Nature (London); Phys. Sci.; 232: No. 30, 77-8(26 Jul 1971).

When a proton of relativistic energy strikes a heavy nucleus it is possible for the target nucleus, or a large amount of it, to recoil with a substantial fraction of the energy of the incident proton, and if this energy is sufficient to penetrate the Coulomb barrier between the recoiling particle and another heavy nucleus in the target, nuclear reactions can occur. Such a process has been invoked to account for the possible production of a nuclide with Z = 112 in a W target irradiated with 24 GeV protons (Marinov et al. Nature 229: 464 (1971)). The present authors attempt to estimate the rate of production of high energy recoil nuclei in such proton-W collisions, and it is thought that the results would be very similar for any other heavy nuclide target. It is found that the cross-section for the production of energetic heavy ions in interactions of protons with heavy nuclei is extremely small, and that the idea of using such recoil nuclei as secondary projectiles to initiate reactions between heavy nuclei is not promising; also that the results reported by Marinov are unlikely to have arisen from such secondary reactions caused by recoil nuclei. The possibility that inelastic proton-W collisions, resulting in break-up of the W nucleus, may provide energetic recoil fragments that could induce secondary reactions is also considered, and found unlikely. According to Batty (Nature Phys. Sci. 232: 78 (1971)), however, there seems to be conflict between these results and available experimental data, and it may be that more complicated interactions can occur. (UK)

59815 STUDY OF PHOTO-NUCLEAR REACTION BY MEANS OF RESIDUAL NUCLEUS METHOD. Kato, Toyoaki; Saito, Tatsuya; Tsai, Hui-tuh; Nomura, Koichi; Sato, Takeo (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 1, 115-20(Oct 1970). (In Japanese).

The dependence of the yield of (γ,n) reactions on the maximum energy of Bremsstrahlung was measured. The targets used were ^{12}C, ^{23}Na, ^{55}Mn, ^{127}I and ^{197}Au. Yield curves obtained are shown, and compared with those by Nathans et al. and by Montalbetti et al. The residual nucleus method was next applied to the study of photonuclear reactions on ^{133}Cs and ^{139}La. Yield distributions of Cs, I, and Sb nuclides produced with 250-MeV bremsstrahlung were measured. Yield curves plotted against the number of emitted particles were of parabolic form, and could be explained in terms of the two-step model of Serber. The results were compared with those by Halpern et al. The deviation from the line of stability on the neutron deficit side is discussed. (Japan)

59816 FRAGMENT YIELDS OF ^{90m}Y, ^{91}Sr, ^{92}Sr, ^{92}Y, ^{93}Y, ^{95}Zr, ^{95}Nb, ^{96}Nb, ^{99}Mo, ^{111}Ag, AND ^{112}Ag FOR THE FISSION OF ^{209}Bi INDUCED BY A 1000-MeV MAXIMUM ENERGY BREMSSTRAHLUNG HAVE BEEN DETERMINED RADIOCHEMICALLY. di Napoli, Vito (Univ., Rome); Laceranza, Angela Maria; Margadonna, Daniele; (and others) Gazz. Chim. Ital.; 101: No. 2, 117-28(1971). (In Italian).

The fragment yields of ^{90m}Y, ^{91}Sr, ^{92}Sr, ^{92}Y, ^{93}Y, ^{95}Zr, ^{95}Nb, ^{96}Nb, ^{99}Mo, ^{111}Ag, and ^{112}Ag for the fission of ^{209}Bi induced by 1000 MeV maximum energy bremsstrahlung have been determined radiochemically. The resulting mass-yield curve was found to be a single symmetrical peak with a width at half maximum of about 19 mass units and a maximum fission yield of 5 percent at a mass number of approximately 101. (auth)

59817 EVIDENCE FOR HIGH-SPIN CORE-EXCITED STATES IN ^{210}Po. Blomqvist, J.; Fant, B.; Wikstroem, K.; Bergstroem, I. (Research Inst. for Physics, Stockholm). Phys. Scr.; 3: No. 1, 9-10(1971).

With the aid of the pulsed α-beam of the 225 cm cyclotron, a 93 nanosecond level in ^{210}Po at 4372.0 keV is found, which is interpreted as a state arising from two protons in the $(h_{9/2})^2_8$ state, coupled to the first 5 state in ^{208}Pb. (auth) (Sweden)

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59818 E2 CORE POLARIZATION BY NEUTRONS IN THE $(i_{13/2})^{-2}$ CONFIGURATION IN ^{206}Pb. Bergstroem, I.; Blomqvist, J.; Fant, B.; (and others) (Research Inst. for Physics, Stockholm). Phys. Scr.; 3: No. 1, 11-12(1971).

With the aid of the ^{204}Hg (α,2n) reaction and the pulsed beam of the 225 cm cyclotron, the 12^+ and 10^+ states of the $(i_{13/2})^{-2}$ configuration in ^{206}Pb at the energies 4027.2 and 3957.6 keV, respectively, have been localized. The partial E2 transition probability for the $12^+ \rightarrow 10^+$ transition has been determined, as well as an effective charge of 0.94 ± 0.04 for the $i_{13/2}$ neutron. It is concluded that the quadrupole polarization charge for the $i_{13/2}$ neutron is about 50% larger than for the $h_{9/2}$ proton. (auth) (Sweden)

59819 SIGN OF "δ", THE AMPLITUDE MIXING RATIO OF GAMMA TRANSITIONS, AND GAMMA--GAMMA–GAMMA ANGULAR CORRELATION STUDIES IN ^{160}Dy. Pande, U. S.; Singh, B. P. (Univ. of Roorkee, India). Can. J. Phys.; 49: 2088-92(1 Aug 1971).

The importance of gamma–gamma–gamma angular correlation in order to study the absolute sign of "δ", the amplitude mixing ratio of gamma transitions, independent of phase convention is given. A study of the triple gamma-rays cascade of 298 keV → 879 keV → 87 keV in ^{160}Dy from the decay of ^{160}Tb was done. (auth) (Canada)

59820 NEUTRON YIELD FROM PROTONS AND DEUTERONS OF MOMENTA BETWEEN 0.85 AND 1.7 GeV/c TOTALLY ABSORBED IN LEAD. West, D.; Wood, E. (Atomic Energy Research Establishment, Harwell, Eng.). Can. J. Phys.; 49: 2061-72(1 Aug 1971).

Neutron yields from protons and deuterons accelerated by the Birmingham synchrotron were measured at a series of momenta up to 1.7 GeV/c in a lead target 10 cm diameter and 60 cm long. The observed yield from deuterons is greater than that expected from two protons each having one half of the deuteron energy but is close to that which can be deduced from the measured proton yield on the hypothesis that stripping reactions are the predominant processes involved in the first interaction. (auth) (Canada)

59821 ENERGY LEVELS OF ^{142}Nd FED BY THE DECAY OF ^{142}Sm. Hayashibe, Shogo; Endo, Yorimasa; Miyata, Takamoto; Tazawa, Hisashi; Shiga, Toshio (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 1, 60-6(Oct 1970). (In Japanese).

Decay of ^{142}Sm produced by (γ,2n) reaction on ^{144}Sm, enriched to 90% or more in mass 144, was studied to investigate the level structure of ^{142}Nd. A Ge(Li) detector and a NaI(Tl) scintillation counter were employed to take singles and coincidence spectra. Beta and internal conversion spectra were observed with a magnetic β-ray spectrometer. The gate for the coincidence measurement was opened at the peak of the 1.576 MeV gamma-ray by the NaI(Tl) counter. The 0.642 MeV gamma-ray was strongly in coincidence with the gate, and a weak peak at 1.320 MeV was observed in the coincidence spectrum. Internal conversion spectra of the K and L + M electrons of the 2.216 MeV transition were taken by the beta spectrometer. The experimental K/L + M ratio was 5.0 ± 0.9. No gamma peak for the 2.216 MeV transition was observed in the singles spectrum with the Ge(Li) detector. The 2.216 MeV transition, therefore, is EO transition, and the level at 2.216 MeV has spin and parity of 0^+. The ratio of transition probability of the 2.216 MeV transition to that of the 0.642 MeV transition, which was also emitted from the 2.216 MeV level, was 0.13 ± 0.05. Five gamma rays having energy levels of 0.642, 1.320, 1.576, 2.389 and 2.841 MeV were observed, and seem to be gamma rays due to the decay of 73 min activity (^{142}Sm). Maximum energy components of positrons were 3.2 and 1.6 MeV. The decay scheme of the decay chain ^{142}Sm → ^{142}Pm → ^{142}Nd was constructed. The level structures of ^{142}Nd were discussed. The strength parameter of the EO transition was obtained and compared with the other data. (Japan)

59822 EVAPORATION OF CHARGED PARTICLES FROM EXCITED Ag AND Br NUCLEI. Fox, Jay A. Columbia, S. C.; Univ. of South Carolina (1971). 139p. University Microfilms Order No. 71-21,843.

Thesis.

A study is presented of singly and doubly charged particles with kinetic energies less than 35 MeV, which are emitted from the silver and bromine nuclei found in nuclear track emulsions after these nuclei have been excited by inelastic collisions with 3.5 GeV/c π^- mesons. The potential barrier method of Lohrmann and Teucher is used to separate interactions with this relatively heavy group of nuclei from those with the lighter constituents of the emulsion. The ratio of heavy to light emulsion nuclei is measured to be 3.6 ± 0.8, a result which agrees with other experiments. The singly and doubly charged particles which stop in the emulsion are identified principally by means of a photometric track width measuring device. A brief discussion of nuclear evaporation theory is given and the energy spectra of the observed singly and doubly charged particles are found to be in fair agreement with the theoretical prediction if a nuclear temperature of T = 5.1 MeV and effective barrier height of V = 1.3 MeV for singly charged particles, and T = 6.8 MeV and V = 8.6 MeV for doubly charged particles is used. The average kinetic energies of these Z = 1 and Z = 2 particles are (12.7 ± 1.2) MeV and (17.9 ± 2.1) MeV respectively, while the theoretical predictions are 11.5 MeV and 17.7 MeV. The variation of these energies with excitation energy agrees with the findings of Bogdanski et al., neither of which agrees with evaporation theory. The ratio of doubly to singly charged particles is found to be 0.268 ± 0.035, in agreement with the theoretical prediction of 0.29 ± 0.04. The excitation energy is 307 MeV, a value which is six percent less than that given empirically. The angular distributions of these singly and doubly charged particles are essentially isotropic, thus agreeing with the evaporation model. Warden has presented evidence that the angular distribution of tracks with no gaps is peaked in a direction transverse to the beam. It is demonstrated that such an effect is probably the result of a systematic error in data acquisition. It is concluded that, with relatively minor exceptions, the experimental results presented are adequately explained by the nuclear evaporation theory. (Diss. Abstr. Int., B)

59823 E4 MOMENTS IN ^{152}Sm AND ^{154}Sm. Stephens, F. S. (Univ. of California, Berkeley); Diamond, R. M.; de Boer, J. Phys. Rev. Lett.; 27: No. 17, 1151-4(25 Oct 1971).

The E4 transition moments between the ground state and the 4^+ rotational state in ^{152}Sm and ^{154}Sm were determined from Coulomb excitation experiments with 10- to 12-MeV ^{4}He projectiles. Quantum-mechanical corrections are applied to the calculations used in the analysis of the data. The resulting E4 moments are about twice those expected from previously measured β_4 deformations. (auth)

59824 MEASUREMENT OF THE VARIANCE OF THE NUMBER OF NEUTRONS EMITTED IN FISSION OF ^{252}Cf AS A FUNCTION OF THE FRAGMENT MASS AND TOTAL KINETIC ENERGY. Gavron, Avigdor (Soreq Nuclear Research Center, Yavne, Israel. Weizmann Inst. of Science, Rehovot, Israel); Fraenkel, Zeev. Phys. Rev. Lett.; 27: No. 17, 1148-51(25 Oct 1971).

The variance of the number of neutrons emitted by individual fragments in fission of ^{252}Cf was measured as a function of the fragment mass and the total kinetic energy released. The variance does not show pronounced "sawtooth" structure as a function of the fragment mass. The correlation coefficient between the excitation energies of complementary fission fragments is thus substantially less than unity for at least some portions of the fragment mass-ratio distribution. (auth)

59825 THERMAL NEUTRON CAPTURE INVESTIGATION OF THE ^{172}Yb AND ^{174}Yb LEVEL STRUCTURES. Alenius, G.; Arnell, S. E.; Schale, C.; Wallander, E. (Chalmers Univ. of Tech., Goteborg). Phys. Scr.; 3: No. 2, 55-62(1971).

The energies and intensities of gamma radiation from thermal neutron capture in ^{171}Yb and ^{173}Yb have been determined by means of a Ge(Li) pair and anti-Compton spectrometer. Internal reactor targets have been used. The reaction Q-values, energies of excited levels and decay schemes of ^{172}Yb and ^{174}Yb have been deduced. The positions of the $K^\pi = 0^-, 1^-$ octupole vibrational states in ^{172}Yb are discussed. (auth)

59826 PRE-EQUILIBRIUM EMISSION IN n, p AND n, α REACTIONS OF CsI. Milazzo-Colli, L.; Braga-Marcazzan, M. G. (CISE, Milan. Univ., Milan). Phys. Lett.; 36B: No. 5, 447-50 (4 Oct 1971).

Spectra of proton and α particles from neutron bombardment at energies from 12 to 22 MeV in CsI are compared with the theory of the pre-equilibrium emission mechanism. This effect is found dominant at the highest neutron energies. Statistical evaporation gives a small contribution. (auth)

Nuclear Theory

Refer also to abstracts 58775, 59265, 59335, 59406, 59612, 59508, 59516–59518, 59526, 59527, 59693, 59707, 59725, and 59741.

59827 (CEA-R-4070) STUDY OF THE MECHANISM OF THE REACTIONS (d,p) AND (d,t) INDUCED BY LOW ENERGY (120 TO 200 keV) DEUTERONS ON ^{9}Be. DETERMINATION OF THE CHARACTERISTICS OF THE EXCITED LEVELS OF ^{11}B OBTAINED BY THE REACTIONS ^{9}Be + d. Perchereau, Jeanine

(Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). 1971. 118p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Paris Univ. (France). Faculte des Sciences.

The angular distributions of the charged products of the reaction ^{9}Be + d were determined for incident energies of 120, 150, and 200 keV. With a view to obtaining a better understanding of such reactions, the previously published experimental results were collated and normalized so as to obtain the changes in the angular dependence of the particles emitted, in the incident energy range of 0.120 to 1.8 MeV. These limits were chosen so as to cover and to go beyond the Coulomb barrier of 1.2 MeV. In the first stage an attempt was made to interpret the experimental data for the reactions ^{9}Be(d,p_0)^{10}Be, ^{9}Be(d,p_1)^{10}Be*, and ^{9}Be(d,t)^{8}Be in the framework of a direct interaction mechanism. The relative importance of the nuclear and coulombic distortions were studied further in the input and output channels. In a second treatment, the hypothesis of a composite nucleus was used. As a result of a study of the changes in the coefficients of the splitting into Legendre polynomials, it was concluded that there exist 4 resonant states of ^{11}B which have as yet unknown characteristics. The work shows that even under favorable conditions, stripping, pickup of low energy deuterons near light nuclei, and also of course stripping of the target-nucleus are practically nonexistent. It is nontheless true that deuteron stripping is slightly favored when the transfer momentum is low. It is stated that although the case is complex it was found that a previous theory often criticized, gives excellent results. In effect, in spite of its adjustable parameters and its attempt to explain as best as possible the real-wave functions, the DWBA has only given results which are competitive with the PWBA. The composite nucleus mechanism is responsible for the emission of protons p_0, tritons t_0 almost totally, protons p_1 to within 11 per cent. These emissions result from decay of ^{11}B states whose characteristics are E = 15.80 MeV Γ = 0.840 MeV spin $1/2^-$ and E = 16.7 MeV Γ = 1.060 MeV spin $3/2^+$ and, less certainly E = 15.12 MeV Γ = 0.750 MeV spin $1/2^+$ as determined from the resonant reactions ^{9}Be(d,α_0)^{7}Li and ^{9}Be(d,α_1)^{7}Li*. This work has also shown that it is improbable that the 16.9 MeV level exists. (auth)

59828 (COO-2022-10) MULTILEVEL ANALYSIS OF ^{235}U SCATTERING CROSS SECTION DATA. Adler, D. B.; Adler, F. T. (Illinois Univ., Ubrana. Dept. of Physics). [1971]. Contract AT(11-1)-2022-1.. 7p. (CONF-711009-1). Dep. NTIS.

For Presentation at joint meeting of the American Nuclear Society; Miami, Fla. (17 Oct 1971).

The procedure used for fitting the high-precision data with the multilevel expansion is based on the derivation of the scattering parameters from the total cross section parameters. Illustrative preliminary results of the uranium-235 analysis are given. (J.F.P.)

59829 (COO-2022-11) AMBIGUITIES IN R-MATRIX PARAMETERS FOR INTERFERING RESONANCES WITH TWO FISSION CHANNELS. Adler, D. B.; Adler, F. T. (Illinois Univ., Urbana. Dept. of Physics). [1971]. Contract AT(11-1)-2022-1. 5p. (CONF-711009-2). Dep. NTIS.

For Presentation at joint meeting of the American Nuclear Society; Miami, Fla. (17 Oct 1971).

Results are summarized which are obtained assuming N well-spaced interfering resonances of the same spin state, having constant Γ_γ, with two fission channels. It is concluded that the apparent nonuniqueness of the R-matrix parameters seems to be inherent to the formalism and not a consequence of the least squares procedures. (J.F.P.)

59830 (CU-1019-82) ROLE OF ANGULAR MOMENTUM AND ISOBARIC SPIN IN TESTS OF THE INDEPENDENCE HYPOTHESIS. Miller, J. M. (Columbia Univ., New York. Dept. of Chemistry). [1971]. 21p. Dep. NTIS.

The range of validity of the compound-nucleus model for the description of nuclear reactions proceeding through continuum states and leading to continuum states is extended if proper account is taken of all of the constants of the motion and of the detailed variation of level density from nucleus to nucleus. Adjustment of the level-density formula for those factors that make the ground state of the nucleus unusually stable can have dramatic effects on the probability for the emission of various types of particles. The conservation of angular momentum along with careful evaluation of the spin dependence of level densities can have large effects on the shapes of energy and angular distributions as well as the probabilities for the emission of the various types of particles. Finally, isobaric-spin conservation can increase the probability for proton emission in proton-induced reactions. This is particularly true when there is a very small probability for proton emission from the T < states of the compound nucleus. (auth)

59831 (IFA-CRD-41) POLARIZATION EFFECTS IN NUCLEAR TRANSFER REACTIONS. Ciocanel, A. (Institutul de Fizica Atomica, Bucharest (Romania)). 1970. 14p. Dep. NTIS (U. S. Sales Only).

A short exposition of the formalism for the transfer processes is presented, and the polarization calculation is accomplished. The physical meaning of these reactions at low energies on light nuclei and the effects of some approximations on the cross sections are also discussed, in the frame of the DWBA-theory. (auth)

59832 (JINR-E4-5890) NUCLEAR CENTRE OF MASS COORDINATE IN THE BLOCH-HOROWITZ THEORY. Palumbo, F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 12p. Dep. NTIS (U. S. Sales Only).

A method is given to obtain intrinsic wave functions in the framework of the Bloch–Horowitz theory. The effects of spuriosity on energy are considered, and as an example previous work on (^{3}He) is analyzed. (auth)

59833 (JINR-E4-5907) CALCULATION OF NEUTRON EQUILIBRIUM PAIRING IN SPHERICAL SINGLE CLOSED SHELL NUCLEI. Bal'butsev, E. B.; Bochnacki, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 18p. Dep. NTIS (U. S. Sales Only).

Neutron pairing in Ni, Sn and Pb isotopes is calculated by minimalization of the total energy under the condition of constant volume. Satisfactory overall agreement with experimental pairing parameters is found in all three cases. (auth)

59834 (KURRI-TR-76) REPORTS OF THE STUDY MEETING ON NUCLEI WITH SHORT LIFE, KUMATORI, OSAKA, JAPAN, 30 JUNE–1 JULY 1969. Iwata, Siro (ed.) (Kyoto Univ. (Japan). Research Reactor Inst.). 30 Jun 1970. 27p. (In Japanese). (CONF-690661).

Separate abstracts were prepared for the various papers in this conference. (R.W.R.)

For abstracts of individual papers see: 57481, 57521, 59781, 59782, 59835, and 59836.

59835 (KURRI-TR-76, pp 1-2) WHY WE STUDY NUCLEI FAR OFF STABILITY LINE. Yoshizawa, Yasukazu (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on nuclei with short life; Osaka, Japan (30 Jun 1969).

In Reports of the study meeting on nuclei with short life.

Meaning of the study on nuclei far off stability line is explained. Mass formula and nuclear stability may be clarified by measuring mass of the nuclei far off the beta-stability line. Alpha decay of the nuclei far off the stability line and proton decay of neutron-deficient nuclei may be found, as well as ordinary alpha and beta decay of nuclei. Mirror nuclei are expected in the region of A ≤ 100, and superallowed transitions are observed. Investigation of double-magic nuclei far off the stability line is important for studying nuclear structure. Deformed nuclei may be found in this region. Study on the origin of chemical elements is interesting. It is considered that the chemical elements were produced from light elements by repeated neutron absorption and beta decay. Thus neutron-rich nuclei are important for the study of the origin of chemical elements. The nuclei far off the stability line are usually short-lived, and on-line study is necessary. The study is in progress with on-line mass separators, and the characteristics of the various separators in use are tabulated. (Japan)

59836 (KURRI-TR-76, pp 3-6) NUCLEI FAR OFF BETA STABILITY LINE AND GROSS THEORY OF NUCLEI. Yamada, Masami (Kyoto Univ. (Japan). Research Reactor Inst.). (In Japanese).

From Meeting on nuclei with short life; Osaka, Japan (30 Jun 1969).

In Reports of the study meeting on nuclei with short life.

Gross theory of nuclei is discussed in relation to nuclei far off beta stability line. Mass of the nucleus is expressed by the Weizsaecker semiempirical mass formula composed of five terms, that is, volume, surface, symmetry, Coulomb, and even–odd terms. Estimation by this formula is in agreement with actual mass data within 1% error. The present mass data, however, were obtained from the nuclei along the beta stability line, and the agreement in the region far from the beta stability line is still uncertain. The mass formula is very important for combining the experimental results and the fundamental theory. Results of calculation by Brueckner, Bethe and others are compared with each term of the mass formula. The surface and symmetry terms have a variation of about 40%. Data for the nuclei far off the stability line are necessary to determine magnitude of the terms precisely. Neutron

XUM

gas far off the stability line is also interesting material, because the nuclear force is relatively simple; accordingly, reliability of calculation is high, and the data about it are also necessary for the study of neutron stars. The nuclei far off the stability line are also useful for the study of the gross theory of beta decay, because measurement of their lifetime and beta spectrum is useful as a check of the nuclear matrix element of the beta decay. (Japan)

59837 (LA-4492) FORMALISM FOR THE [POLARIZED] $T(d,n)^4He$ AND $^3He(d,p)^4He$ REACTIONS. Gammel, John L.; Keaton, P. W. Jr.; Ohlsen, Gerald G. (Los Alamos Scientific Lab., N. Mex.). Jul 1970. Contract W-7405-eng-36. 71p. Dep. NTIS.

The formalism required to describe the $T(d,n)^4He$ or $^3He(d,p)^4He$ reaction when all particles may be polarized is discussed. The relation among the various sets of spin-1 tensors is stated explicitly, so that the formulas applying to a particular experiment may be written easily in terms of any desired system. (auth)

59838 (LA-4549) ENDF FORMATS AND PROCEDURES FOR PHOTON PRODUCTION AND INTERACTION DATA. Dudziak, Donald J. (comp. and ed.) (Los Alamos Scientific Lab., N. Mex.) Jul 1971. Contract W-7405-eng-36. 87p. (ENDF-102(Rev.) (Vol.2)). Dep. NTIS.

The ENDF formats for storage of photon production and photon interaction data are presented as are procedures for entering these data. Formats for photon production data are a revision of those given in Los Alamos Scientific Laboratory Report LA-3801 (ENDF-111) and supersede the earlier format. Sample sets of photon production data are given in the new format. Procedures are given to minimize ambiguities in entering data in the format and to facilitate writing processing codes to use the data. Classes of data for which formats and procedures are specified include photon production cross sections, multiplicities, transition probability arrays, angular distributions, energy spectra, and energy-angle distributions; also, photon interaction cross sections, secondary angular, energy, energy-angle distributions, and atomic form factors are included. (auth)

59839 (LA-4735) FINITE-DIFFERENCE SOLUTION OF AXIALLY SYMMETRIC NUCLEAR SINGLE-PARTICLE POTENTIALS. Fiset, E. O.; Nix, J. R.; Bolsterli, M. (Los Alamos Scientific Lab., N. Mex.). Aug 1971. Contract W-7405-eng-36. 7p. Dep. NTIS.

An implicit finite-difference method for solving Schrödinger's equation for axially symmetric static nuclear single-particle potentials was investigated. The method used is an improved version of the procedure previously outlined. The finite-difference equations are obtained in prolate spheroidal coordinates by use of a variational principle. The eigenvalues and eigenvectors of the resulting band matrix are found by use of inverse iteration, with the linear system of equations solved directly. The method works satisfactorily, but requires approximately 25 times as much computing time as an expansion of the wave function in deformed harmonic-oscillator basis functions, for comparable accuracy in the eigenvalues. (auth)

59840 (NP-19027) EXACT GROUND STATE OF SOME ONE-DIMENSIONAL N-BODY SYSTEMS WITH INVERSE ("COULOMB-LIKE") AND INVERSE-SQUARE ("CENTRIFUGAL") PAIR POTENTIALS. Note No. 315. Calogero, F.; Marchioro, C. (Rome Univ. (Italy). Istituto di Fisica). 5 May 1971. 8p. Dep. NTIS (U. S. Sales Only).

The exact ground state, and the corresponding binding energy, is exhibited, of the system composed of N (nonidentical) quantum-mechanical particles interacting in one dimension via the potential $V_{ij}(x_i-x_j) = g(x_i-x_j)^{-2} + (f_i-f_j)(x_i-x_j)^{-1}$. Some special choices of the constants f_i and g, that yield examples of possible physical interest, are discussed. (auth)

59841 (ORO-4119-1) RESEARCH IN EXPERIMENTAL AND THEORETICAL NUCLEAR PHYSICS. Progress Report. Liu, K. H.; Lynk, E. T.; Toosi, M. A.; Singh, Zorawar (Southern Univ., Baton Rouge, La. Dept. of Physics). 15 Jul 1971. Contract AT(40-1)-4119. 26p. Dep. NTIS.

A new treatment of the finite-range interaction within the framework of the distorted-wave Born-approximation (DWBA) was developed. Higher-order corrections to zero-range stripping calculations can now be more easily carried out to approach the limit of the "exact" result. The application of this method to the DWBA deuteron stripping calculations is recommended. Futhermore, the effect of the D state of the deuteron on proton polarization and deuteron analyzing power for the reaction $^{40}Ca(d,p)^{41}Ca$ leading to the ground state at several bombarding energies was studied. Previous studies of this reaction in the zero range and finite range have described j-dependent features of the cross section and vector analyzing powers. Preliminary results are in agreement with these. Finite-solid-angle corrections for two five-sided Ge(Li) detectors were measured by using the collimated-beam method. Data were taken with source-to-detector distances of 5, 7, and 10 cm for both the cylindrical and the trapezoidal detectors. The investigated detectors had volumes of 42 cm^3 and 19 cm^3, respectively. Reasonable agreement with the calculations of D.C. Camp and A. L. Van Lehn [Nucl. Instrum. Methods, 76: 192 (1969)] was found. (auth)

59842 (RT/FI-(71)6) SASSI: A FORTRAN PROGRAMME FOR THE CALCULATION OF NEUTRON SCATTERING FROM A SPHERICAL OPTICAL POTENTIAL. Benzi, V.; Fabbri, F.; Zuffi, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 16 Feb 1971. 17p. Dep. NTIS (U. S. Sales Only).

The SASSI program, written for an IBM 360 computer in FORTRAN IV, calculates the neutron scattering cross sections from a spherical optical potential with a spin-orbit term. The program outputs are the total and reaction cross sections, the shape elastic total and differential cross sections, the total and differential compound cross sections for elastic scattering and inelastic scattering for a single excited level, the total and differential elastic cross sections, and the sum of all the total compound inelastic cross sections. (auth)

59843 (SC-DR-710320) PROCESSING CODES FOR GROUP-AVERAGED DISCRETE ORDINATES CROSS-SECTION TABLES. Adams, Kenneth G.; Renken, James H.; Flinchum, Joann H. (Sandia Labs., Albuquerque, N. Mex.). Sep 1971. 42p. Dep. NTIS.

Three codes are discussed, COLAPS, EDIT, and MODIFY, that operate on any group-averaged cross-section tables which are used by transport codes such as DTF69, TWOTRAN, TDA, and MORSE. Each code is a separate entity. When used together, they provide a rather complete capability to modify and edit group-averaged cross-section tables. Familiarity with the notation and nomenclature in existing discrete ordinates transport codes is assumed. The programs are written in FORTRAN and run on the CDC6600. (auth)

59844 COMPARISON OF ANALOGOUS $\Delta T = 0$ β- AND γ-RAY DECAYS IN THE NUCLEAR 2s-1d SHELL. Bardin, T. T.; Becker, J. A. (Lockheed Palo Alto Research Lab., Calif.). Phys. Rev. Lett.; 27: No. 13, 866-9(27 Sep 1971).

M1, $\Delta T = 0$ radiative widths Γ_γ in the 2d-1s shell are compared with the widths computed with the Gamow-Teller β-decay ft values, Γ_β. For twelve of nineteen cases, $\Gamma_\gamma = (2 \pm 1)\Gamma_\beta$. (auth)

59845 Q-VALUE DEPENDENCE OF MULTINUCLEON TRANSFER REACTIONS. Toepffer, Christian (Univ., Frankfurt am Main). Phys. Rev. Lett.; 27: No. 13, 872-4(27 Sep 1971).

The regular behavior of multinucleon-transfer cross sections in reactions between heavy ions as a function of the Q values Q_{gg} for the ground-state transitions is explained in the molecular-wave-function method. The coupled equations of the scattering problem are solved analytically. (auth)

59846 REGGE POLE ANALYSIS OF GLORY SCATTERING. Sromovsky, Lawrence Anthony. Madison, Wis.; Univ. of Wisconsin (1971). 181p. University Microfilms Order No. 71-16,102.

Thesis.

Recent experiments studying the elastic scattering of α particles from spinless nuclei reveal a strong backward peak and a near-backward angular distribution similar in form to that of the meteorological glory. The usual explanation of this latter phenomenon in terms of surface waves suggested that an investigation of near-backward α-particle scattering might provide considerable insight into the properties of the nuclear surface. Near backward spinless scattering from several potentials, including square and Wood-Saxon wells of real and complex depth, are studied within the framework of Regge pole and partial wave analysis. The uniform asymptotic expansions of the Bessel and Hankel functions are used to treat the square well in detail. The treatment of the Wood-Saxon well relies heavily on numerical computations and analogies with the square well. The analysis of near backward scattering in terms of Regge poles provides a simple description of the intensity, energy dependence, and angular distribution which characterize the glory for all the potentials studied. The suggested connection of the glory with the surface properties of the potential is found to be valid in so far as these properties affect certain Regge poles of the scattering function (those near $l = kR$, where k is the incident wave number and R the potential radius). These poles are found to be the common source of all the phenomena termed glories. In some cases only one pole is involved; this is most likely for an absorbing Wood-Saxon well. In other cases a cooperative effect is operative; this occurs for the real Wood-

Saxon well and for the square well at special values of the index of refraction N. The glory for a square well with N = 1.333 (the scalar version of the meteorological glory) is found to be a relatively weak one involving many poles but little cooperation among them. (Diss. Abstr.)

59847 NUCLEAR RESONANCE REACTIONS IN 1967. Lane, A. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp.115-30 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

59848 DEUTERON-INDUCED REACTIONS. Butler, S. T. (Univ. of Sydney. pp 167-86 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

59849 NUCLEAR MODELS. Flowers, B. H. (Univ. of Manchester, Eng.). pp 289-315 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

59850 MANY-BODY PROBLEMS AND TWO-BODY FORCES. Brown, G. E. (NORDITA, Copenhagen). pp 317-26 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

59851 NUCLEAR GROUND-STATE PROPERTIES IN THE REACTION MATRIX THEORY. Wong, C. W. (Oxford Univ.). pp 327-32 of Methods and Problems of Theoretical Physics. /Bowcock, J. E. (ed.). New York; American Elsevier Publishing Co., Inc. (1970).

From Conference on methods and problems of theoretical physics; Birmingham, England (Jun 1967).

59852 ft ASYMMETRY IN MIRROR GAMOW–TELLER β DECAY: BINDING-ENERGY EFFECTS. Wilkinson, D. H. (Univ. of Washington, Seattle). Phys. Rev. Lett.; 27: No. 15, 1018-22 (11 Oct 1971).

It is shown that the systematic asymmetry observed between positron and negatron emitters in mirror Gamow–Teller β decay is not due to binding-energy differences between the respective β-transforming nucleons; it must be due either to a fundamental weak-interaction effect or to a nuclear-structure effect of some type not yet quantitatively discussed. (auth)

59853 ENERGY DISPLACEMENT OF DIPOLE ISODOUBLETS. Akyuez, R. Oe.; Fallieros, S. (Brown Univ., Providence). Phys. Rev. Lett.; 27: No. 15, 1016-18(11 Oct 1971).

The difference in energy between the two isospin components of the giant dipole resonance in a nucleus with nonvanishing neutron excess is studied. An estimate is presented where this difference is expressed as a function of the mass number and the ground-state isospin of the nucleus. (auth)

59854 FINITE-RANGE INTERACTION IN DEUTERON STRIPPING REACTIONS. Liu, K. H. (Southern Univ., Baton Rouge, La.). Contract AT(40-1)-4119. Phys. Rev. Lett.; 27: No. 15, 1010-12(11 Oct 1971).

A new treatment of the finite-range interaction in stripping reactions within the framework of the distorted-wave Born approximation (DWBA) is presented. By this method, the finite-range calculation for the differential cross section in deuteron stripping is expressed as a power series expansion that approaches the "exact" results with computer time comparable to that for zero-range calculations. (auth)

59855 THEOREM FOR ENERGY-WEIGHTED AVERAGES OF SPECTROSCOPIC FACTORS. Shakin, C. M.; Da Providencia, J. (Univ., Coimbra). Phys. Rev. Lett.; 27: No. 16, 1069-71 (18 Oct 1971).

It is shown that, for a system with strong correlations, the centroid of the spectroscopic amplitudes for particle removal is given by the single-particle energy (defined appropriately) times the occupation probability of the orbit. (auth)

59856 INTERACTION CURRENT CONTRIBUTIONS TO PARITY NON-CONSERVING NUCLEAR γ-TRANSITIONS. Gari, M.; Huffman, A. H. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Phys. Lett.; 36B: No. 5, 442-6(4 Oct 1971).

Parity non-conserving interaction current contributions to nuclear γ-transitions required by gauge invariance are calculated and discussed. Arguments are given that the strangeness conserving currents should contribute to the one pion-exchange parts of the interaction. (auth)

59857 SIMPLE COUPLING SCHEME FOR EXACT SHELL MODEL CALCULATIONS. Wong, S. K. M.; Zuker, A. P. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Lett.; 36B: No. 5, 437-41(4 Oct 1971).

Shell model calculations are carried out in an antisymmetrized weak coupling basis. Dramatic reductions in dimensionality are achieved with little loss of accuracy and great gain of physical insight when compared with the conventional exact results. (auth)

59858 NUCLEON–NUCLEUS INELASTIC SCATTERING WITH REALISTIC NUCLEON–NUCLEON INTERACTIONS. Stafford, Richard David. Nashville; Vanderbilt Univ. (1971). 143p. University Microfilms Order No. 71-20,312.

Thesis.

A study was made of the problems inherent in applying the DWBA attack to nucleon–nucleus inelastic scattering through the use of realistic nucleon–nucleon interactions. The interaction forms discussed include a local approximation to the Brueckner G matrix suggested by Kuo and Brown as a result of their work in finite nuclei with the Hamada–Johnston interaction, local interactions with momentum dependence (repulsive terms proportional to p^2), and separable nonlocal interactions. Sample calculations are made with the Kuo–Brown interaction for proton inelastic scattering through excitation of a few low-lying states in the nuclei ^{90}Zr, ^{6}Li, and ^{14}N. The ^{6}Li and ^{14}N calculations include the tensor force. The ^{90}Zr calculation marks the first use of the Kuo–Brown effective interaction in inelastic scattering, and the ^{6}Li and ^{14}N calculations are the first application of the tensor part of that interaction. Inelastic scattering with momentum-dependent interactions and separable nonlocal interactions are examined formally, and calculational procedures are developed. (Diss. Abstr. Int., B)

59859 STUDIES IN QUADRUPOLE COULOMB EXCITATION. Lea, Suzanne Moore. Durham, N. C.; Duke Univ. (1970). 108p. University Microfilms Order No. 71-21,542.

Thesis.

The optimal method of calculating the quantum-mechanical differential cross section for quadrupole Coulomb excitation in the distorted-wave Born approximation is explained. Previous works have restricted the maximum number of partial waves used in expanding the distorted waves such that the calculation becomes inaccurate for low energies and/or forward scattering angles; this work removes that inaccuracy by using any desired number of partial waves up to a maximum of 300. A computer program was written which utilizes this approach. It reproduces known Coulomb excitation data in the classical limit and point-nucleus approximations. With a nucleus of finite size, however, significant differences from the point-nucleus case appear at energies near the Coulomb barrier. Data on excitation of nuclei through isobaric analog states are now available; they indicate that the interference between Coulomb excitation and the isobaric analog resonance should be significant. Codes that specify the scattering matrix for the nuclear interaction to have the form of a single-level Breit–Wigner resonance (a form appropriate to isobaric analog resonances) were written; these codes use optical-model and resonance parameters to calculate the phase shifts of the incoming and outgoing waves in the nuclear potential. Preliminary attempts to fit the data with this formulation are given. (Diss. Abstr. Int., B)

59860 COULOMB ENERGIES OF ISOSPIN TRIPLETS IN 2s–1d SHELL. Rappleyea, Chloe Annette. Boulder, Colo.; Univ. of Colorado (1970). 118p. University Microfilms Order No. 71-21,621.

Thesis.

Coulomb energies and second energy differences in the region $18 \leqq A \leqq 42$ are calculated for 0^+, $T = 1$ ground states. Preliminary calculations are done for masses 18 and 42 by using mixed configurations and radial wave functions derived from a Woods–Saxon potential well. To a good approximation, the second energy difference is just the Coulomb interaction energy of the last two protons in ^{18}Ne and ^{42}Ti. However, these preliminary calculations show that contributions from inclusion of four-particle–two-hole pair excitations in the nuclear wave functions of each triplet are important. The calculations also show that inclusion of opposite-parity orbits in nuclear wave functions may be necessary to reproduce experimental second energy differences. Based on these results, a detailed analysis of pairing interactions in the second

XUM

energy difference is done by including a pairing residual interaction in the shell-model Hamiltonian. A mathematical formalism that includes p–n pairs as well as p–p and n–n pairs is developed to calculate nuclear wave functions with this residual interaction. Inclusion of a pairing force depresses Coulomb energy expectation values for N = Z members of isospin triplets and is responsible for raising second energy differences. By using pairing strengths derived from fitting energy levels for mass-18 and mass-42 nuclei, results of the calculation reproduce experimental second energy differences extremely well. (Diss. Abstr. Int., B)

59861 THEORY OF STRUCTURAL CORRECTIONS IN PAIR CONVERSION COEFFICIENTS IN M1 TRANSITIONS OF NUCLEI. Barysaglebski, L. A.; Pazoiski, S. V. (Belorussian State Univ., Minsk. Vitebsk State Teaching Inst., USSR). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk; No. 2, 81-4(1969). (In Belorussian).

The relation of electronic factors with nuclear parameters in structural magnetic dipole theory of internal conversion coefficients for various types of static nuclear charges for Z = 20, 62, and 64 was studied. It is shown that variations of the electronic factors for transformation to the nuclear charge distributions, which are closer to experimental values, as in the case of conversion coefficients on the K shell for the M1 transitions of the nuclei, are noticeable for the electronic factor for the first nuclear parameter and are significant for the electronic factors for the other nuclear parameters. This leads to variations of the nuclear parameters determined from experimental work on internal conversion coefficients. (tr-auth)

59862 HARMONIC OSCILLATOR POTENTIAL INSERTIONS IN PARTICLE LINES. Clement, David M. (Univ. of California, Los Angeles). Nucl. Phys.; A174: No. 3, 561-71(1971).

Brueckner calculations of the binding energy of finite nuclei are usually performed with harmonic oscillator single-particle wave functions. It is, therefore, computationally more convenient to keep the oscillator potential in intermediate states and then subtract out its effects by calculating higher-order diagrams involving potential insertions in particle lines. It is found that the lowest-order diagram involving a single potential insertion in a particle line can be approximated by $-\kappa\bar{U}^{c.m.}$, where κ is the wound integral and $\bar{U}^{c.m.}$ is the average over the c.m. potential energy of the pairs of particles in the nucleus that occupy relative S states. (auth)

59863 PAIRING FACTORS FOR ELECTRIC TRANSITION OPERATORS: A COMMENT ON THE PRECEDING PAPER. Brussaard, P. J. (Rijksuniversiteit, Utrecht). Nucl. Phys.; A174: No. 3, 551(1971).

Difficulties in the application of Siegert's theorem are noted. Several errors in a recent paper by P. J. Brussaard [Nucl. Phys., A158: 440(1970)] are pointed out. The most significant concerns the fact that the commutator $[\rho, H]$ in general does not lead to a single-particle operator; in particular, the nonlocal character of the pairing interaction of the BCS model may be incompatible with the assumption that it does. (R.W.R.)

59864 SIEGERT'S THEOREM AND THE PAIRING FACTORS FOR ELECTRIC TRANSITION OPERATORS. Allaart, K. (Vrije Univ., Amsterdam). Nucl. Phys.; A174: No. 3, 545-50(1971).

It is argued that recent formulas for the electric transition operators in the BCS model and the subsequent conclusion that Siegert's theorem may not be applied in this case are incorrect. It is pointed out that these incorrect results are obtained using a prescription of Rose and Brink [Rev. Mod. Phys., 39: 306(1967)], which is very confusing. A modification of this prescription is given, and the correct form of the electric transition operators is discussed. (auth)

59865 FACTORIZATION AND FOLDED DIAGRAMS IN THE GOLDSTONE LINKED-CLUSTER SERIES. Becker, Richard L. (Oak Ridge National Lab., Tenn.); Jones, Robert W. Nucl. Phys.; A174: No. 3, 449-67(1971).

Factorization of insertions relative to skeletons in the Goldstone linked-cluster series can be achieved to a higher degree than is usually done by introducing folded diagrams. This is illustrated by a fourth-order example containing a second-order insertion. The generalization to all orders is found to be contained in the recent treatment of factorizability by Jones and Mohling [Nucl. Phys., A151: 420(1970)]. (auth)

59866 DENSE NEUTRON MATTER WITH REALISTIC INTERACTIONS. Pandharipande, V. R. (Niels Bohr Inst., Copenhagen. Tata Inst. of Fundamental Research, Bombay). Nucl. Phys.; A174: No. 3, 641-56(1971).

The energy of the neutron gas is studied with the Reid and Bressel–Kerman–Rouben soft-core potentials up to a density of 4.5 neutrons/Fn^3. Very approximate estimates for neutron-gas and -solid energies are presented also for the Hamada–Johnston hard-core potential. The short-range correlations are treated by a simple variational method in which the cluster expansion of the energy expectation value with a Jastrow wave function is truncated at the lowest-order two-body clusters. Healing constraints are introduced in the variation from qualitative comparison with lowest-order Brueckner theory, and a differential equation is obtained for the correlation function by minimizing the energy. The effective interaction for use with uncorrelated wave functions, given by this procedure is also interpreted with the Moszkowski–Scott separation method. It is shown that the lowest-order calculations may be reasonable for the Reid and Bressel–Kerman–Rouben soft-core potentials, whereas their applicability with Hamada–Johnston hard-core potential is doubtful for $\rho \gtrless 0.7\ F^{-3}$. The results give an approximate equation of state for dense neutron matter (the order of uncertainty in it is due to that in the neutron–neutron interaction at short range) and may be useful in neutron-star structure investigations. (auth)

59867 PHASE TRANSITIONS IN NUCLEAR FISSION. I. Ohta, Kohichi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 45: No. 5, 1493-1514(May 1971).

Within the framework of the state-independent pairing-plus-octupole model in the cluster representation, heavy nuclei in the actinide region are shown to undergo phase transitions of the second kind, between an asymmetric phase and a symmetric one, as the excitation energy is raised. For a description of the nucleus at high excitation energies, the Hartree–Fock–Gorkov approximation is used. The valence states responsible for the fission process are restricted within one major shell in each cluster, because the vicinity of the transition points is of interest. The situation is complicated, since there also occurs the superconducting–normal phase transition. The calculated transition points are in qualitative agreement with experiment, although more detailed and systematic experiments are required. (auth)

59868 GROSS THEORY OF FIRST FORBIDDEN β-DECAY. Takahashi, Kohji (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 45: No. 5, 1466-91(May 1971).

The gross theory of nuclear β decay developed by Yamada, Takahashi, and Koyama [Bull. Sci. Eng. Res. Lab., Waseda Univ., No. 31132: 146(1965); Progr. Theor. Phys. (Kyoto), 41: 1470 (1960); ibid., 44: 663(1970)] for allowed transitions is extended to include the first-forbidden transitions. The effect of the giant resonance is taken into consideration by using sum rules. The β-strength functions of both allowed and first-forbidden transitions and the β-decay half-lives are calculated. It is shown that the theory can explain the gross properties of the first-forbidden transitions as well as the allowed ones. In particular, the theoretical β-strength functions of neutron-deficient heavy nuclei are compatible with experimental data recently obtained by Hansen et al. [Nucl. Phys., A151: 609(1970)]. It is also shown that the first-forbidden transitions often predominate over the allowed transitions in heavy nuclei. (auth)

59869 UNIFIED DESCRIPTION OF INELASTIC AND QUASI-ELASTIC ELECTRON SCATTERING FROM NUCLEI. Balashov, V. V. (Moscow State Univ); Grishanova, S. I.; Kabachnik, N. M.; Kulikov, V. M. Phys. Lett.; 36B: No. 4, 325-7(20 Sep 1971).

On the basis of the particle-hole shell model and the method of the strong coupling of channels, the cross section for electrodisintegration of the nucleus is calculated from threshold up to high energies including both the region of the giant resonance and the quasi-elastic maximum. It is shown that the channel coupling leads to a considerable neutron yield. (auth)

59870 NATURE OF THE TWO-PION EXCHANGE CONTRIBUTION TO THE NUCLEAR FORCE. Riska, D. O. (NORDITA, Copenhagen); Chemtob, M. Phys. Lett.; 36B: No. 4, 313-16(20 Sep 1971).

Recent calculations of the two-pion contribution to NN scattering phase parameters are analyzed in terms of central, tensor and spin-orbit phase shifts. Conclusions are drawn concerning the qualitative features expected for the corresponding components of the nuclear force in the intermediate range region. (auth)

59871 ISOVECTOR MONOPOLE STATE AND COULOMB DISPLACEMENT ENERGIES. Auerbach, N. (Tel-Aviv Univ., Ramat-Aviv, Israel). Phys. Lett.; 36B: No. 4, 293-6(20 Sep 1971).

A correction to the Coulomb displacement energies arising from

XUM

the isovector monopole state is calculated using a sum rule approach. (auth)

59872 0^+ AND 1^+ UNLIKE PARTICLE-HOLE STATES IN DEFORMED ODD-ODD NUCLEI AND β-STRENGTH FUNCTIONS. Gabrakov, S. I.; Kuliev, A. A.; Pyatov, N. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 36B: No. 4, 275-7 (20 Sep 1971).

The properties of collective 0^+ and 1^+ states built of unlike particle-hole excitations in deformed odd-odd nuclei have been investigated in a microscopic approach. Their β-strength functions are calculated and compared with other predictions. (auth)

59873 TIME REVERSAL INVARIANT FORMULATION OF AVERAGE COMPOUND CROSS SECTIONS. Vager, Z. (Weizmann Inst. of Science, Rehovot, Israel. State Univ. of New York, Stony Brook). Phys. Lett.; 36B: No. 4, 269-70(20 Sep 1971).

A symmetrized expression of the independence of formulation and decay of the averaged compound cross section results in a modified Hauser–Feshbach formula. Such a formula changes estimates of the average compound elastic cross section by almost a factor of two. (auth)

59874 MASS PARAMETER OF FISSION ASYMMETRY. Kurochkin, S. G.; Cherdantsev, P. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 3, 157-9(1971). (In Russian).

The liquid drop model had been successfully used in studying the fission of atomic nuclei. Toroidal coordinates were adopted for describing the spherical fragments from the fission process. A mathematical relation was developed which was utilized to plot a family of curves representing the mass parameter of fission asymmetry. (K.S.W.)

59875 TEORIYA SLOZHNYKH YADER. (Theory of Complex Nuclei). Solov'ev, V. G. Moscow; Izdatel'stvo Nauka Glavnaya Redaktsiya Fiziko-Matematicheskoi Literatury (1971). 560p.

Basic contemporary theory of complex nuclei is considered, accompanied by pertinent accounts of various models, as the independent particle, generalized nucleus, the independent quasi particle, with pertinent methods of attack on the problem: Hartree–Fock, self-consistent field method, method of projection, and approximation methods. A semimicroscopic theory of nuclear vibrations in deformed and spherical nuciei is presented, including the structure of excited 0^+-states, the single and double phonon states, and interaction with phonons. 586 references. (K.S.W.)

59876 RESONANCE PHENOMENA IN NUCLEAR REACTIONS. Lovas, Istvan (Central Research Inst. for Physics, Budapest). Magy. Fiz. Foly.; 19: No. 3, 209-66(1971). (In Hungarian).

Resonances observed in nuclear reactions induced by one-nucleon bombardment are studied. The two historic approximation methods used for resonances are described: 1. the mathematical formal technique based on Schrodinger's equation of many-nucleon systems, and 2. the dynamic technique which has a more specific physical meaning. In the second case it is attempted to derive the dynamic properties directly from experimental data within the framework of the shell model. The anticipated development of the dynamic theory of nuclear reactions and its limitation are outlined, followed by application of the theory to resonance phenomena. A model of resonance phenomena in nuclear physics that may be solved exactly is developed. The equations applicable to two-, three-, and many-particle systems are examined taking resonances in elastic neutron scattering into account. The derived model has been applied to the description of isobaric analog resonances. Preliminary studies have been completed to generalize the field of application of the new model. (Doctoral dissertation, 55 references). (TTT)

59877 COMPRESSIBILITY UNDER DEFORMATION OF THE NUCLEAR HARTREE-FOCK FIELD. Castel, B. (Queen's Univ., Kingston, Ont.); Svenne, J. P. Can. J. Phys.; 49: 2028-30(1 Aug 1971).

The "compressibility under deformation" effect observed in isotopic shift experiments is analyzed in a deformed Hartree–Fock model. The empirical parameter ξ deduced previously from experiment is found to be consistent with the calculated estimate using a realistic interaction in four f-p shell nuclei. (auth) (Canada)

59878 DEPENDENCE OF HARTREE–FOCK SOLUTIONS IN sd-SHELL NUCLEI ON SPIN-DEPENDENT FORCES. Jensen, A. S.; Harvey, M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys.; 49: No. 14, 1837-49(15 Jul 1971). (AECL-3898).

The Hartree–Fock solutions and the stabilities of these solutions are examined for all 4n nuclei in the (2s,1d) shell for various strengths of the spin-dependent forces. The relationship with a possible vibrational structure is discussed. (auth) (Canada)

59879 EFFECT OF LEVEL INTERFERENCE IN THE SLOW-NEUTRON CROSS-SECTIONS OF FISSILE NUCLEI. Koenig, D. R.; Michaudon, A. (CEN de Saclay, Gif-sur-Yvette, France). J. Nucl. Energy; 25: No. 7, 273-84(Jul 1971).

Simulated multilevel and single-level slow neutron cross sections for a fissile nucleus were calculated using, in both cases, the same level parameters corresponding to two spin states and three fission exit channels per spin state. The effect of level interference due to the fission exit channels was then evaluated from the comparison of these two sets of cross sections. Single-level analysis leads, in both cases, to distributions of "apparent" level parameters which are closely similar. This analysis demonstrates that, for such cross sections, interference effects contribute relatively little to the distortion of the apparent level parameters compared to the effects of the overlapping of non-interfering levels and the loss of very small levels. (auth)

59880 RADIATIVE CORRECTION FOR ELASTIC ELECTRON-AND POSITRON-NUCLEUS SCATTERING. Breuer, Hans (California State Coll., Pa.). Nucl. Data, Sect. A; 9: No. 3, 169-233 (Jun 1971).

Four formulas for the radiative correction to elastic electron- or positron-nucleus scattering are presented. Numerical values derived from them are given for atomic numbers 1, 2, 4, 8, 16, 50, and 90; energies 20, 50, 100, 200, 500, 1000, 2000, and 5000 MeV; scattering angles 30°, 60°, 90°, 135°, and 180°; and $\Delta E/E$ from 0.1 to 0.0002. A discussion of the radiation length together with computed values is included. (auth)

59881 INTRODUCTION TO X-COEFFICIENTS AND A TABULATION OF THEIR VALUES. Csonka, Paul L.; Haratani, Thomas; Moravcsik, Michael J. (Univ. of California, Livermore). Nucl. Data, Sect. A; 9: No. 3, 235-64(Jun 1971).

X-coefficients, as defined here, can be used to simplify the calculation of particle polarizations (vector polarizations as well as higher-order, so called, tensor polarizations) and spin correlations. If not more than two particles have nonzero spin in the reaction under study, then all polarizations and correlations can be expressed as linear combinations of X-coefficients, and only the numbers multiplying them depend on the form factors (invariant amplitudes). If three or four particles have nonzero spin, then bilinear combinations of X-coefficients appear, etc. The X-coefficients do not depend on the dynamics of the reaction and can be tabulated once and for all. They do depend on the spins of the participating particles and are given in this table for those spin values which are the most important ones from a practical point of view. (auth)

59882 ISOBARIC MASS EQUATION IN $A = 4n + 1$ NUCLEI. Auerbach, N. (Tel-Aviv Univ., Israel); Lev, A.; Kashy, E. Phys. Lett.; 36B: No. 5, 453-5(4 Oct 1971).

The parameters of the isobaric mass equation are calculated for the $T = 3/2$ multiplets in $A = 4n + 1$ nuclei, for $n = 2$ to $n = 10$. (auth)

59883 ALPHA CLUSTERING IN LIGHT NUCLEI WITH A SKYRME INTERACTION. Khadkikar, S. B. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Lett.; 36B: No. 5, 451-2(4 Oct 1971).

Equilibrium α-cluster configurations are calculated with a Skyrme interaction. Considerably less clustering is obtained than in previous calculations which used a B1 effective interaction, thus showing that the large α-clustering was due to the strong p-state repulsion required for saturation with density-independent forces. (auth)

59884 METHOD OF CALCULATING LOW-LYING SPECTRA IN SPHERICAL NUCLEI. Khodel, V. A.; Saperstein, E. E. (Kurchatov Inst., Moscow). Phys. Lett.; 36B: No. 5, 429-32(4 Oct 1971).

A method of calculating the long-range components of the effective interaction, Γ, between quasiparticles in nuclei is proposed. The equation for Γ in terms of the universal interaction amplitude Γ^u is deduced. The general expression for Γ^u containing 8 invariant amplitudes is given. A simple example is considered. (auth)

59885 THEORETICAL AND EXPERIMENTAL RESULTS ON INTERNAL BREMSSTRAHLUNG ACCOMPANYING ELECTRON

XUM

CAPTURE. (REVIEW). Kadar, Imre. ATOMKI (At. Kut. Intez.) Kozlem.; 13: No. 1-2, 29-51(May 1971). (In Hungarian).

If the energy of the recoil nucleus is disregarded, the total decay energy of electron capture, minus the bond energy of the electron, is carried away by the emitted neutrino. However, a secondary process also takes place, although with a much lower probability: in the radiative electron capture, the total decay energy is divided between the neutrino and a γ quantum, the so-called internal bremsstrahlung quantum. Determination of the maximum energy of the internal bremsstrahlung represents the only practical method to measure the total decay energy involved in electron capture. The radiative electron capture is a secondary process: the weak interaction is perturbed by an electromagnetic interaction, as a result of which a photon may be emitted during the electron capture. The perturbation is due to the sudden change of the electric and magnetic moments of the atom during the capture process. The original 1940 Morrison–Schiff theory and subsequent experimental measurements are reviewed, examining the reasons for the observed deviations. Subsequent theoretical studies of Glauber and Martin took radiative electron captures at higher shells into consideration; the more recent studies are also examined. The experimental techniques considered include spectrum shape measurements, determination of the intensity of the internal bremsstrahlung, angular distribution, angular correlation studies, and circular polarization measurements. (Review article, 57 references). (TTT)

XUM

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstract 57637.

59886 (WCAP-7735) TOPICAL REPORT: SENSITIZED STAINLESS STEEL IN WESTINGHOUSE PWR NUCLEAR STEAM SUPPLY SYSTEMS. Hazelton, W. S. (comp.) (Westinghouse Electric Corp., Pittsburgh, Pa. Monroeville Nuclear Center). Aug 1971. 20p. Dep. NTIS.

The results of an evaluation of the use of sensitized stainless steel in pressurized water reactor components are summarized. Tests conducted on the steel included intergranular corrosion cracking in various environments, stress analyses on piping, effects of hardsurfacing operations, effects of nitrogen on corrosion cracking, inspection procedures for sensitized components, and effects of localized high-oxygen-content coolant on components. Precautions taken during the fabrication and installation of sensitized components are described. (H.D.R.)

59887 SOME OF THE PROBLEMS AND THE PRESENT WORLD SITUATION OF ATOMIC POWER PLANT CONSTRUCTION. Bede, Gabor (Technical Univ., Budapest). Atomtech. Tajek.; 13: No. 7, 428-38(Nov 1970). (In Hungarian).

Nuclear power plants have become a strong competitor of conventional power plants. The planned construction and cost figures of nuclear power plants in USA, England, West Germany, France, Japan, and the Socialist countries are listed. The latest figures show that nuclear power plants are not more expensive than conventional power plants when individual units are larger than 500 MW(e). 17 references. (TTT)

59888 ECONOMIC OUTLOOK FOR ATOMIC ENERGY. Krymm, R. Atomtech. Tajek.; 13: No. 7, 419-27(Nov 1970). (In Hungarian).

The fast rate of growth of the nuclear power generating capacity is analyzed, reviewing the cost figures of the various reactor types, the competitive position of nuclear power plants during the next 10 to 15 years, their expected distribution in various geographic areas and long-range expectations from 1985 to the end of the century. The study was limited to HWR, BWR, natural-uranium-fueled heavy-water reactors and advanced gas-cooled reactors. The required capital investment and fuel cycle costs were examined and compared. It is expected that the problem of reliable nuclear fuel supply will be solved by long-range international agreements, in which protection of the national coal interest will be taken into account. Prevention of atmospheric contamination may result in excessive costs with respect to conventional power plants. It is anticipated that in many geographic areas large nuclear agro-industrial complexes will be established around nuclear power plants for desalting seawater and to serve the needs of chemical industry. The large power plants will be interconnected, creating an international network with a capacity expected to reach 5000 MW. (TTT)

59889 TRENDS IN THE PRODUCTION OF HEAT AND ENERGY IN THE FEDERAL REPUBLIC OF GERMANY. Kruppe, H. (Technische Ueberwachungs-Vereine eV, Essen). Brennst.-Waerme-Kraft; 23: No. 6, 285-9(Jun 1971). (In German).

From the development of steam and heat generation over the last decade a prognosis is made on further development up to 1980, using statistical information on boiler and furnace design, on power output and temperature levels, and on the breakdown into groups of operators. The marked effects on this developmen resulting from the regulations concerning air pollution or the inroads made by nuclear energy and natural gas are analyzed. 12 references. (auth)

59890 NUCLEAR ENERGY IN SWEDEN, 1970. Brynielsson, H. (Aktiebolaget Atomenergi, Studsvik, Sweden). pp 149-61 of Proceedings of the Seminar on Nuclear Power. /Rastogi, B. P. (ed.). Bombay; Department of Atomic Energy (1970).

From Seminar on nuclear power; Bombay, India (17 Jan 1970).

In Sweden 3,300 MW(e) capacity of nuclear power is under construction and the forecast for 1985 is about 15,000 MW(e). Long term prospects of the low-grade uranium shale of Billingen are interesting. The new company ASEA-ATOM for development, manufacture and marketing of nuclear reactors, fuel and components is owned in equal parts by the Government and ASEA. Other forms of collaboration with Government and foreign companies are described. The Atomic Energy Company, concentrating its activities to Studsvik, is responsible for the Government financed development work in collaboration with the nuclear industry and the utilities. (auth)

59891 INDIAN EXPERIENCE IN CONSTRUCTION OF NUCLEAR POWER REACTORS. Rao, V. Surya (Rajasthan Atomic Power Project, India). pp 163-81 of Proceedings of the Seminar on Nuclear Power. /Rastogi, B. P. (ed.). Bombay; Department of Atomic Energy (1970).

From Seminar on nuclear power; Bombay, India (17 Jan 1970).

The Indian Department of Atomic Energy has embarked, in collaboration with Canada, on the installation of Rajasthan Atomic Power Project—a 400 MW(e) nuclear power station. With the transfer of know-how of design and engineering from Canada, self-sufficiency is being achieved by gathering experience and first hand knowledge in construction. This has brought in its wake abundant problems like procurement of equipment, utilization of available materials, and adopting modern techniques for maximizing the utility of these materials both in manufacture and during construction with guaranteed assurance leading to safety. RAPP has overcome satisfactorily most of the above problems including a large scale indigenization program and has effectively set the pace in India for further nuclear power stations. (auth)

59892 CONSTRUCTION PROBLEMS AT KALPAKKAM. Srinivasan, M. R. (Madras Atomic Power Plant). pp 183-9 of Proceedings of the Seminar on Nuclear Power. /Rastogi, B. P. (ed.). Bombay; Department of Atomic Energy (1970).

From Seminar on nuclear power; Bombay, India (17 Jan 1970).

At Kalpakkam, near Madras, a twin unit CANDU type Atomic Power Station with each unit having an output of about 200 MW(e) is planned and work has commenced on the first unit. Though the basic features of the reactor system are similar to those of the Rajasthan reactors, a number of changes are being incorporated for reasons of economics or as a result of local conditions. The reactor containment building is being executed as a prestressed concrete structure designed to withstand the full internal pressure under the maximum credible accident. As part of the post-accident safety systems, a pressure suppression pool is being incorporated into the reactor building in order to keep both the temperature and pressure conditions in the areas occupied by personnel to safe values. A double containment principle is adopted for the reactor building as the inner prestressed wall is enclosed by an outer shielding wall with provisions made for venting of the gases in a controlled manner through a stack. Certain features of construction at Kalpakkam on the conventional side of the plant merit special mention. For example, the shoreline on the eastern sea coast of India is subjected to heavy littoral drift and is also visited by cyclones of high intensity more or less regularly. This has necessitated the adoption of submarine tunnel for drawing the cooling water for the condensers and the construction of an approach jetty extending about 500 meters into the open sea in order to facilitate the construction of the intake structure and also enable its maintenance. The existence of a high sub-soil water table has dictated the choice of the continuous cast diaphragm wall technique for a number of sub-structures of the power station. So far as the equipment is concerned, most of it, both nuclear and non-nuclear, is being contracted out to industry in India. (auth)

59893 STRETCH-OUT IN POWER PLANT SCHEDULES. Patterson, R. W. Power Eng.; 75: No. 9, 40-3(Sep 1971).

An attempt is made to formulate realistic schedules for fossil and nuclear power plant projects. The delay factors and adverse trends in construction and licensing are discussed. (H.D.R.)

59894 DEVELOPMENT OF THE SEQUENTIAL AUTOMATION OF THE THIRD UNIT OF THE CHINON NUCLEAR POWER STATION. Sonrel, Jean (Electricite de France, Chinon). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 88, 23-8(Mar 1971). (In French).

The developments arising from decisions taken on the running and general operation of Chinon 3 from the time of the preliminary studies are described. The principal difficulties which resulted in the modification of the initial automatic units are analyzed. The measures taken during the start up to ensure the correct actuation of the system are described. (France)

59895 REVIEW OF CIVIL ENGINEERING PROBLEMS IN CONSTRUCTION OF NUCLEAR POWER STATIONS. Yoshida, Minoru (Kansai Electric Power Co. Inc., Osaka). Tsuchi To Kiso; 18: No. 12, 1-3(Dec 1970). (In Japanese).

In view of advantages of economy and no public hazards, building of nuclear power stations is remarkable in Japan. Civil engineering problems in this field are reviewed about power station loca-

XUM

tion and technology. Three factors are important for selection of the nuclear power station site; (a) sparse population, (b) good ground condition, and (c) easy access to condenser cooling water. The possibility of increasing the sites in Japan is also considered. The most important thing in nuclear power stations is seismic design of the over-all station, which also concerns intake of cooling water. Soft ground foundations present problems, and regions with geological faults are to be averted. Recent development in employment of prestressed concrete vessels and also underground installation of reactors are reviewed. (Japan)

59896 FIRST UNIT OF SAINT-LAURENT-DES-FAUX POWER PLANT: GENERAL CHARACTERISTICS, POWER RUN-UP. Babinet, Gonzague; Bellin, Andre (Electricite de France, Tours). Ind. At.; 15: No. 2, 21-32(May 1971). (In French).

The first of the two natural uranium-graphite-gas reactors of Saint-Laurent-des-Eaux was put into service on March 14, 1969: a little more than six months after the first coupling into the network of the two turbo-alternator units (2 × 250 MW). The structure of the reactor is based on the integrated arrangement, i.e. the chief components of the primary circuit are integrated in a prestressed concrete pressure vessel. Two computers take care of the handling and the surveillance of the unit. The startup marked the completion of tests on various materials and the overall test phases prior to loading the reactor with the pressure vessel and bringing it up to temperature. (France)

59897 PERFORMANCE ANALYSIS OF BWR EMERGENCY CORE COOLING SYSTEM DESIGNED FOR SHIMANE NUCLEAR POWER STATION OF CHUGOKU ELECTRIC POWER COMPANY. Takashima, Yoshie; Horiuchi, Tetsuo (Hitachi Ltd., Ibaraki, Japan). Hitachi Hyoron; 53: No. 2, 106-10(Feb 1971). (In Japanese).

The emergency core cooling system designed for Shimane nuclear power station consists of two core spray lines, four low pressure water injection lines, one high pressure water injection line and one auto relief line. These lines are composed so as to maintain sufficient core cooling capacity and multiplicity against accidental loss of coolant under assumption of any possible area of break, even if external AC supply is lost. Performance analysis is based on results of performance tests of each line and analytical models. These tests are in regard to characteristics of the core spray cooling and reflooding and depressurization characteristics of the high pressure water injection system. Analyzed conditions are loss of coolant occurring at any position in the coolant pipe works with any possible area of break. The external AC supply and one out of two emergency diesel generators are assumed to be lost. The severest case is a full break in the recirculation pipe works. Maximum cladding temperature during the failure is 850°C, much lower than the chemical activation temperature of Zircaloy-2. This failure leads at the worst to perforation of the cladding in a few percentages of fuel rods. The other failures cause no perforation. The results are satisfactory. (Japan)

59898 PRUDENCE AND TECHNOLOGY: A TECHNOLOGIST'S RESPONSE TO PREDICTIONS OF CATASTROPHE. Weinberg, Alvin M. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 37-40(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The predicted population growth and increasing electric power demands of the world are analyzed. The need for advancing technology to improve the quality of life for the present and future world populations is discussed. The utilization of available energy sources for world power demands is described. The proposed role of nuclear power in meeting the power requirements of the world is presented. 7 references. (D.C.C.)

59899 INSTRUMENTATION AT CONNECTICUT YANKEE AND MAINE YANKEE ATOMIC POWER STATIONS. Beckley, Bruce B.; Wood, Edwin, C. (Maine Yankee Atomic Power Co., Westboro, Mass.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 443-8(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The changes made to the instrumentation and control equipment at Connecticut Yankee since plant startup are summarized. There have been additional changes made in the design of Maine Yankee's control system beyond those already made in Connecticut. These fall into two categories: the first is changes to the nuclear steam supplier's package; the other category includes the additions made to the basic instrumentation for operator ease and improved performance. These changes between Connecticut and Main Yankee designs are described. (auth)

59900 NUCLEAR POWER AND NUCLEAR POWER PLANTS. Part 1 of Kaernkraftdrift av Fartyg. Goteborg; Stiftelsen foer Skeppsbyggnadsteknisk Forskning ([1971]). (In Swedish).

General information such as journal articles, statistics, and commercial news items about nuclear power in different countries is given along with data for specific power reactors and nuclear power plants. It consists of about 300 loose sheets which are revised and supplemented continuously. (Sweden)

59901 NUCLEAR ENERGY IN EUROPE. Casa, A. F.; Fiorentini, P.; Perilli, M. L.; Sansone, M. M. Com. Naz. Energ. Nucl., Notiz.; 17: No. 6, 41-92(Jun 1971). (In Italian).

A review of the present situation of nuclear energy in Europe is included. Nuclear plants and the fuel cycle (from mining to reprocessing) are discussed. (auth)

59902 SAFETY INSPECTION ON PROSPECTIVE TSURUGA REACTOR INSTALLATION (PROTOTYPE ATR) OF POWER REACTOR AND NUCLEAR FUEL DEVELOPMENT CORPORATION. Genshiryoku Iinkai Geppo; 15: No. 12, 53-64(Dec 1970). (In Japanese).

A prototype ATR in Tsuruga is to be situated on the Tsuruga Peninsula facing the Sea of Japan. It is D_2O-moderated and cooled with boiling light-water; its heat output is 557 MW (165 MW(e)); fuel is low-enriched UO_2 or mixed U–Pu dioxides, with Zircaloy-2 cladding. Topics discussed include: outline of the installation such as site conditions and the nuclear reactor; safety design and safety measures on nuclear and thermal design, fuel, control, containment and cooling, wasters, safety, aseismatic design, etc.; radiation exposure in normal operation due to radioactive wastes; accidents concerning reactivity and mechanical failure; serious and imaginary hazards; and technological ability of the applicant. (Japan)

59903 NUCLEAR POWER AS SOURCE OF ENERGY IN JAPAN. NUCLEAR POWER AND ENERGY ECONOMICS. Sakisaka, Masao (Japan Energy Economic Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi; 13: No. 1, 29-33 (Jan 1971). (In Japanese).

Future problems of nuclear power as source of energy are based on the petroleum industry in this decade. Increase of energy demand must be supplied by petroleum. Therefore, economics of the nuclear power energy must be considered in comparison with energy cost of the petroleum energy. Development cost of new oil field is rising, and pollution control is intensified in countries with a large amount of petroleum consumption. Therefore, it is inevitable to get into high energy cost age. Nuclear power plants are therefore objects of attention, and incorporation of the nuclear power plants in energy supply has been increased in advanced countries. Expected nuclear power plants in Japan are described with respect to energy demands in the future. (Japan)

59904 NUCLEAR POWER AS SOURCE OF ENERGY IN JAPAN. URANIUM ENRICHMENT. Imai, Ryukichi (Japan Atomic Power Co., Tokyo). Nippon Genshiryoku Gakkaishi; 13: No. 1, 45-50(Jan 1971). (In Japanese).

Uranium enrichment becomes a very important problem in nuclear fuel for proven light water reactors. The uranium enrichment as a big science in Japan is described in view of nuclear power policy. Nuclear power plants in Japan are based on light water reactors at present. Therefore demand of the uranium enrichment is expected to become 8,000 to 13,000 t SWU per year in 1985, and a part of the nuclear fuel must be supplied domestically. However, as enrichment technique is not established now, it is the most important development research for nuclear energy industry. The enrichment development in Japan has been carried out by two methods, gas diffusion and gas centrifuge method. Schedule of the development by both methods is presented. (Japan)

59905 NUCLEAR POWER AS THE SOURCE OF ENERGY IN JAPAN. FORECAST OF NUCLEAR POWER GENERATION IN JAPAN. Miyake, Shin (Federation of Electric Power Companies, Tokyo). Nippon Genshiryoku Gakkaishi; 13: No. 1, 34-40(Jan 1971). (In Japanese).

Factors of reducing power reactor construction cost are described: large scale of plants, rationalization of design, standardization, and so on. Factors of lessening unit power cost are explained: reliability of equipment, increase in fuel burnup, and fuel cycle. Safety aspects are dealt with on the following: principle, plant safety design, radiation protection, site, earthquake, etc. Among items for future studies are: station site and seismic design, waste disposal, plant-operation automation, efficient fuel utilization, uranium enrichment, spent fuel transport and reprocessing, etc. (Japan)

59906 THERMAL AND NUCLEAR POWER GENERATION ENVISAGED FOR ACTIVE 1970's. Sakai, Takeshi (Hokuriku Electric Power Co. Inc., Toyama, Japan). Karyoku Hatsuden: 21: No. 12, 1285-94(Dec 1970). (In Japanese).

The introduction of nuclear power into the conventional pattern of power generation for Japan during the 1970's is discussed. Requirements for its introduction on a national basis are securing of energy resources, saving of foreign currency, and diversifying of energy resources. Large power companies have advantages in nuclear power generation because of the merit of large plant capacity and multi-plant power stations. Factors to make nuclear power generation economically advantageous for small power companies are discussed, including cost reduction of facilities, easy access to station sites, cooperative wide area operation, nuclear power complexes, etc. Turning to thermal power generation, its advantages are described, such as shorter period of construction, establishment of petroleum complexes, etc. Finally, problems of nuclear fuel supply and enrichment are described. (Japan)

Operation and Economics

59907 (CONF-710606-15) THE NEW ENGLAND POWER EXCHANGE. Mochon, Harry H. Jr. (New England Power Exchange, West Springfield, Mass.). [nd]. 11p.

From seventeenth annual meeting of the American Nuclear Society; Boston, Mass. (13 Jun 1971).

The New England Power Exchange (NEPEX) consists of joint planning and dispatching groups for bulk electric power. The NEPEX master-satellite dispatch center system is described, and system operating functions and problems are discussed. (H.D.R.)

59908 (DOCKET-50016-130) ENRICO FERMI ATOMIC POWER PLANT. Report for May 1971. (Power Reactor Development Co., Detroit, Mich.). 13 Oct 1971. 19p. (PRDC-EF-93). Dep. NTIS.

59909 (DOCKET-50219-149) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Failure of Isolation Condenser Line Break Protection. (Jersey Central Power and Light Co., Morristown, N. J.). 30 Sep 1971. 2p. Dep. NTIS.

59910 (DOCKET-50245-94) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrence No. AO-71-19. (Millstone Point Co., Hartford, Conn.). 8 Oct 1971. 2p. Dep. NTIS.

An operations incident involving a malfunction of the pressure control system for the turbine is described. A force imbalance in the number one control valve at rated pressure caused the high pressure trip of the reactor. Corrective actions are described. (D.C.C.)

59911 (DOCKET-50245-96) MILLSTONE NUCLEAR POWER STATION, UNIT NO. 1. Start-Up. (Northeast Utilities Service Co., Hartford, Conn.). 23 Mar 1971. 7p. Dep. NTIS.

59912 (DOCKET-50245-99) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrence No. AO-71-20. (Millstone Point Co., Hartford, Conn.). 22 Oct 1971. 6p. Dep. NTIS.

On October 10, 1971, a malfunction in the turbine pressure control system caused a pressure transient and a high flux reactor trip. The trip was followed by a vessel blowdown which was caused by a relief valve which opened and failed to close. Corrective actions are described. (D.C.C.)

59913 (DOCKET-50263-88) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. HPCI Problems Experienced During Start-Up. (Northern States Power Co., Minneapolis, Minn.). 18 Oct 1971. 5p. Dep. NTIS.

59914 (TID-25818) GUNDREMMINGEN NUCLEAR POWER PLANT. Monthly Report, July 1971. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 13 Aug 1971. 65p. (In German). Dep. NTIS.

The overhaul and refuelling work was completed on schedule on 11 July 1971. The reactor protection system, shut-down safety, and temperature coefficient were then checked and the plant restarted on 16 July 1971. The plant then operated at full power until the end of the month. The specific activity of the primary circuit water and exhaust gas were about a third of the values measured before the shut-down. (auth)

59915 MODERN POWER STATION PRACTICE. VOLUME 8. NUCLEAR POWER GENERATION. London; Pergamon Press (1971). 394p. £5.

The subject is dealt with under the headings: nuclear physics (basic physical concepts, nuclear reactions, the nuclear fission reaction, neutron slowing down and the heterogeneous thermal reactor), nuclear power reactors (reactor as a heat source, steam cycles and types of thermal reactor), British nuclear power plant (siting, design of nuclear power station plant, layout and development potential), nuclear power station operation (irradiation effects, effects of temperature, fuel cycles, instability, reactor kinetics, reactor control, reactor safety, neutron flux measurements, reactor power level measurements, temperature measurements, coolant measurements, safety circuits, sector servo control-rod system, reactor industrial television equipment and neutron flux scanning), and nuclear techniques (commissioning a nuclear power station, properties of reactor materials, health physics, legislation affecting nuclear power stations, nuclear fuel management and latest developments). (UK)

59916 DEVELOPMENT OF NUCLEAR POWER TECHNICAL SCHOOL IN THE RHEINSBERG TRAINING AND EXPERIMENTAL NUCLEAR POWER PLANT. Flach, G.; Hiersemann, R. (VEB Kernkraftwerke, Rheinsberg, Ger.). Kernenergie; 14: No. 5, 159-63(May 1971). (In German).

On basis of the position of the Rheinsberg nuclear power technical school in the Unitary Socialist System of Education, the educational, training, and perfecting concepts are presented. Aim, substance, and methods of acquirement and absorption of knowledge on nuclear power plant technology, abilities, and dexterities are given corresponding to the specific categories of qualification. Center of this concept is the qualification oriented to production techniques, pairing theoretical knowledge with the practical experience at hand. Therefore, the Rheinsberg nuclear power technical school performs part of technological qualification of present and future personnel and workmen in connection with nuclear industry. (auth)

59917 DRESDEN 2 INCIDENT OF JUNE 5, 1970. Cagle, C. D. Nucl. Safety; 12: No. 5, 538-46(Sep-Oct 1971).

On June 5, 1970, while Dresden Unit 2 was undergoing power testing and was operating at approximately 75% power [1875 MW(t), 623 MW(e)], a spurious signal in the reactor pressure-control system altered the steam flow to the turbine and caused a turbine trip followed by a reactor scram. Subsequent erratic water-level and pressure control in the reactor vessel, compounded by a stuck indicator pen on a water-level monitor-recorder and inability of the isolation condenser to function as needed, led to discharge of steam and water through safety valves into the reactor dry well. Electric cables were damaged, and electric motors developed low-resistance problems. No significant amount of radioactive contamination was discharged to the environment. There was no pressure damage of the reactor vessel or the dry-well containment walls. Recovery included replacing some electric cables with improved cables having higher temperature ratings, rerouting other electric cables, drying electric motors, reorienting the discharge direction of safety valves, revising the reactor pressure-control system, improving the capability of the isolation condenser, and revising operating and emergency procedures. The reactor remained shut down until Aug. 8, 1970. Two to 3 weeks of this downtime was ascribed to refueling. 3 references. (auth)

59918 REACTOR AVAILABILITY AND STATION RELIABILITY FOR CONTINUITY OF SERVICE. Hagen, E. W. Nucl. Safety; 12: No. 5, 499-515(Sep-Oct 1971).

The average availability of first-generation nuclear power reactors to produce uninterruptibly a supply of thermal energy was determined to be 83.4% for seven commercially operated electricity-generating stations by reviewing the station operating reports for a 3-year period. The safest nuclear power reactor is one that is in normal steady-state operation, and therefore it was pertinent to determine the causes of abnormal operation or unscheduled shutdowns. Operational deviations and unplanned station shutdowns were analyzed and categorized into those related to heat-transfer systems, instrumentation and controls, and the electric turbine-generator power system. The central problem areas were found to be leaks in the heat-transfer system, difficulties with the control-rod drives in the primary system, and both leaks and turbine controls in the secondary plant. From the data available a figure of merit was produced to evaluate the unscheduled shutdowns and also to give a comparative evaluation of station service reliability for use of utility operators. 27 references. (auth)

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59919 OUTLOOK FOR NUCLEAR POWER IN AUSTRALIA. Griffiths, D. R. (Australian Atomic Energy Commission, Lucas Heights). Search; 2: No. 9, 333-7(Sep 1971).

Prospects for nuclear power in Australia are considered with reference to the world nuclear power position. The two factors thought most important in influencing the decisions of utilities in favor of nuclear plant, are costs involved in meeting pollution control requirements, and uncertainties regarding the future price of fossil fuel. A brief consideration is made of present Australian fossil fuel reserves and consumption and this is related on a state by state basis to the possible adoption of nuclear power. Nuclear power is not competitive at present, but should become more attractive during the 1980's. (Australia)

59920 NUCLEAR ECONOMICS AND CHANGE. McNelly, M. J.; Armitage, A. C. Pub. Util. Fortn.; 88: No. 6, 19-26(16 Sep 1971).

The impact of change on nuclear economics, and, more particularly, the impact of change on the relative costs of generation of nuclear versus oil and coal is examined. To do this, major components of nuclear, coal, and oil generation costs were calculated on a mills per kilowatt-hour basis for 1970 start-up plants and then reevaluated for plant starts five and ten years later. Brief reference is made to how such trends translate into the forecast growth of nuclear installations in the United States through 1985. (auth)

59921 COST BENEFIT ANALYSIS OF THE CHOICE BETWEEN NUCLEAR AND OTHER FUELS. Jones, G. K. 15p. of Operational Research Society Conference. London; Operational Research Society (1969). (CONF-691137-1).

From Operational Research Society Conference; Eastbourne, England (Nov 1969).

A case study in cost benefit analysis is presented which illustrates some of the practical difficulties involved. The study considers the choice between two possible fuels for a new power station: nuclear, using an advanced gas-cooled reactor (A.G.R.), or conventional coal-firing. After a resumé of recent fuel policy, the cost characteristics of both A.G.R. and coal stations are considered. The standard Discount Cash Flow (D.C.F.) method of financial assessment is described, involving forward simulation of the C.E.G.B. generating system. A full social cost benefit analysis is then described, and estimates given of some of the main differences from the normal D.C.F. analysis. One of the main factors considered is the redundancy caused in the mining industry by choosing a nuclear station rather than a coal-fired one. The primary and secondary effects of such redundancies on the cost benefit equation are considered for various assumptions about redeployment of the miners. Other important factors in the cost benefit equation are enumerated, including the correct marginal price of coal and the correct discount rate to be used. The analysis shows that the factors considered are important and could affect the final choice of fuel. (auth) (UK)

59922 TECHNOLOGICAL DEVELOPMENT IN THERMAL AND NUCLEAR POWER GENERATION IN THE 1970'S. Miyakawa, Yasuhiro (Tokyo Electric Power Co. Inc.). Karyoku Hatsuden; 21: No. 12, 1295-1302(Dec 1970). (In Japanese).

In the 1970's, efficient operation of whole power supply systems will be emphasized, and thus thermal and nuclear power plants are required to respond to change from start-up to full load operation as fast as possible. To meet these demands of fast response and stability, an advance from the traditional static optimization control to dynamic optimization control is necessary. In other words, so-called adaptive control is required, by which optimum operation is possible by recognizing dynamic characteristics of a system, computing and changing set values of controllers automatically. To realize the above requirement, identifiers or dynamic characteristics analyzers are needed. The most difficult and basic problem is the system stability or the identifier itself being one of the elements of a closed loop. The identifier is classified and analyzed mathematically, and its circuits are discussed in detail. (Japan)

59923 CHAPELCROSS MELT-OUT AND RECOVERY OPERATIONS. Weir, C. G. (United Kingdom Atomic Energy Authority, Annan, Scotland). pp 23-9 of Active Working on Reactors. London; British Nuclear Energy Society (1971).

From Meeting on active working on reactors; London, England (1 Oct 1970). See CONF-701054.

The observations and the actions taken at the time when a channel of fuel over-heated are described, together with the results of the subsequent inspection and the preparations made for the recovery operation. An account is also given of the sequence of the channel clearing operations, the difficulties encountered and the probable causes of the incident. After outlining the procedures used for decontaminating both the fabric of the building and the inside of the gas circuit, a brief summary is presented of the start-up tests and the subsequent operation at power. (auth) (UK)

59924 SAINT-LAURENT-DES-EAUX REACTOR I FUEL MELT DOWN INCIDENT: 17 OCTOBER, 1969. Knockaert, A. (Centrale Nucleaire, Saint-Laurent-des-Eaux, France); Feru, J.; Teste du Bailler, A. pp 31-3 of Active Working on Reactors. London; British Nuclear Energy Society (1971).

From Meeting on active working on reactors; London, England (1 Oct 1970). See CONF-701054.

During a routine re-fuelling operation, a graphite flow-restrictor was mistakenly loaded at the top of a fuel-element channel. This resulted in an excessive over-heat and five fuel-elements melted, provoking at the same time the destruction of the catch-pot placed at the bottom of the channel. The restoring work of the installation included: the recovery of the major parts of uranium (90%), the installation of a total filtration of the cooling gas, and the modification of the Burst Cartridge Detection (B.C.D.) System. The investigation inside the vessel, the organization of the operations, and the health physics organization are described. (auth) (UK)

59925 CEGB EXPERIENCE OF IN-PILE WORKING. Brown, V. (Central Electricity Generating Board, Berkeley, Eng.). pp 37-44 of Active Working on Reactors. London; British Nuclear Energy Society (1971).

From Meeting on active working on reactors; London, England (1 Oct 1970). See CONF-701054.

At virtually every C.E.G.B Nuclear Power Station it has been necessary to reinstate or recover failed components within the reactor. In some cases the outage time of generating plant to carry out recovery exercises was lengthy and expensive. The more notable exercises are examined, the design and material failures causing incidents are discussed, and the mechanics of the recoveries and the recovery tool developments are outlined. (auth) (UK)

59926 HEALTH PHYSICS CONTROL. Wheatley, B. M. (Central Electricity Generating Board, Berkeley, Eng.). pp 45-6 of Active Working on Reactors. London; British Nuclear Energy Society (1971).

From Meeting on active working on reactors; London, England (1 Oct 1970). See CONF-701054.

Although hazards cannot be measured directly, acceptable risks can be related to radiation doses in specified organs. The prediction of their doses and confirmatory measurements on the individual can only be derived from measurements of the environment or of surface dose on the individual. The choice of economic and reliable methods of controlling risks to workers and the estimation of their doses involves special professional skills. (auth) (UK)

59927 TRIAL OF NO. 1 PLANT IN MIHAMA NUCLEAR POWER STATION OF KANSAI ELECTRIC POWER COMPANY. Hamaguchi, Shunichi (Kansai Electric Power Co. Inc., Osaka). Karyoku Hatsuden; 22: No. 2, 115-23(Feb 1971). (In Japanese).

Testing of No. 1 plant in Mihama nuclear power station is in power raising phase. The performed tests are function test in hot state, fuel charging test and power raising test, peculiar to PWRs. The function test in hot state is performance test of reactor, machinery and equipments in primary cooling systems and reactor auxiliary systems, carried out under normal operating conditions, but before charging fuel. The power raising test is performed at five different levels including full power. Load shutdown test is performed at three levels. On Aug. 8, 1970, first parallel operation was successful, and 10 MW of power was supplied into system. (Japan)

59928 NUCLEAR POWER AS SOURCE OF ENERGY IN JAPAN. ECONOMICS OF NUCLEAR FUEL CYCLE. Takei, Mitsuo (Japan Energy Economic Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi; 13: No. 1, 40-5(Jan 1971). (In Japanese).

Economics of nuclear power plants may be prescribed by arrangement, capacity and efficiency of each component in nuclear fuel cycle system. One most important nuclear power policy is securing of industrial facilities for the components. Development work of securing uranium ore abroad for the nuclear fuel cycle is described. For fuel processing, business tie-up situation of its industry is given. Fuel reprocessing is one of most important problems at present in Japan. Economizing the fuel reprocessing and shift to private industry system in future are considered as important matters, and then radioactive waste disposal problem is presented in respect of its technical development for safety management. (Japan)

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59929 GENTILLY PIONEERS ADVANCED CONCEPTS IN REACTOR DESIGN, CONTROL, AND VERSATILITY. Mod. Power Eng.: 65: 58-61(May 1971).

Quebec's first nuclear power station produced its first electricity on April 6, 1971. Advantages of its BLW system over PHW reactors are discussed. Station operation is described under the following headings: reactor control, fuelling machine control, computer system, CRT graphic display, program development and turbine by-pass. (F.S.A.) (Canada)

59930 ELECTRIC FACILITIES OF MIHAMA NUCLEAR POWER STATION KANSAI ELECTRIC POWER CO. Inoue, Toru; Iriko, Teruo (Mitsubishi Electric Corp., Kobe, Japan). Mitsubishi Denki Giho; 45: No. 3, 316-30(Mar 1971). (In Japanese).

The electric facilities of Mihama nuclear power station are described. The major design features of the system with equipment ratings are discussed, and some of the special design considerations required for the electrical auxiliary system of the nuclear power station are also included. (auth) (Japan)

Safety and Siting

59931 (DOCKET-1155-136) LA CROSSE BOILING WATER REACTOR. Nuclear Instrumentation Automatic Gain Control System. (Dairyland Power Cooperative, La Crosse, Wis.). 27 Sep 1971. 24p. Dep. NTIS.

Power testing of the instrumentation automatic gain control system is described. (D.C.C.)

59932 (DOCKET-1155-137) LA CROSSE BOILING WATER REACTOR. Coolant Systems Corrosion Surveillance Program. (Dairyland Power Cooperative, La Crosse, Wis.). 25 Feb 1971. 36p. Dep. NTIS.

The corrosion rate of A335, P-11 steel used in the forced-circulation piping of the LaCrosse Boiling Water Reactor (LACBWR) is studied. Corrosion specimens were inserted in the piping and wall-thickness baseline data were taken before the reactor was placed in service. The first examination of corrosion specimens after installation and the first wall thickness measurements made since baseline data were determined are presented. The results indicate that: A335, P-11 steel possesses good general corrosion resistance in stagnant water; the material is subject to crevice corrosion; the material appears to be subject to erosion in flowing water; and the ultrasonic technique used to measure wall thickness is accurate to about ±0.020 inch. (auth)

59933 (DOCKET-1155-138) LA CROSSE BOILING WATER REACTOR. Technical Specifications, Change No. 3. (Division of Reactor Licensing (AEC), Washington, D. C.). 14 Oct 1971. 7p. Dep. NTIS.

Revised technical specifications are presented concerning the use of respiratory protective equipment for personnel. Protection factors for the respiratory equipment are included. (D.C.C.)

59934 (DOCKET-50003-92) INDIAN POINT STATION, UNIT NO. 1. Exposure of Four Employees to Airborne Radioactivity on September 12, 1971. (Consolidated Edison Co. of New York, Inc., New York). 13 Oct 1971. 8p. Dep. NTIS.

59935 (DOCKET-50010-96) DRESDEN NUCLEAR POWER STATION, UNIT 1. Supplement to Proposed Change No. 17 to Operating License DPR-2. (Commonwealth Edison Co., Chicago, Ill.). 7 Oct 1971. 12p. Dep. NTIS.

Requested additional information is presented concerning performance evaluation of the emergency core cooling system. (D.C.C.)

59936 (DOCKET-50146-93) SAXTON REACTOR. Technical Specifications, Change Request No. 49. (Saxton Nuclear Experimental Corp., Pa.). 18 Oct 1971. 3p. Dep. NTIS.

Revised technical specifications are presented concerning the increase in hydrogen pressure ratings for the primary coolant purification system. (D.C.C.)

59937 (DOCKET-50146-94) SAXTON REACTOR. Technical Specifications, Change Report No. 25. (Saxton Nuclear Experimental Corp., Pa.). 18 Oct 1971. 48p. Dep. NTIS.

Revised technical specifications are presented concerning the increase in hydrogen pressure ratings for the primary coolant purification system. (D.C.C.)

59938 (DOCKET-50155-93) BIG ROCK POINT NUCLEAR PLANT. Technical Specifications. (Consumers Power Co., Jackson, Mich.). 1 May 1964. 84p. Dep. NTIS.

59939 (DOCKET-50206-126) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Technical Specifications, Proposed Change No. 7 (Revision). (Southern California Edison Co., Los Angeles). 22 Oct 1971. 12p. Dep. NTIS.

Revised technical specifications are presented concerning an increase in the average burnup limit for Cycle 2 operation from 17000 MWD/MTM to 18000 MWD/MTM. (D.C.C.)

59940 (DOCKET-50206-127) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Technical Specifications, Proposed Change No. 8. (Southern California Edison Co., Los Angeles). 22 Oct 1971. 26p. Dep. NTIS.

Revised technical specifications are presented concerning control rod insertion limits for Cycle 3 operation. (D.C.C.)

59941 (DOCKET-50237-203) DRESDEN NUCLEAR POWER STATION, UNIT 2. Additional Information Regarding Fuel Performance. (Commonwealth Edison Co., Chicago, Ill.). 8 Oct 1971. 5p. Dep. NTIS.

59942 (DOCKET-50244-81) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT NO. 1. Technical Supplement Accompanying Application to Increase Power, Amendment 3. (Rochester Gas and Electric Corp., N. Y.). 8 Oct 1971. 17p. Dep. NTIS.

Requested additional information is presented concerning the power increase to 1520 MW(t). Information presented includes: personnel retraining requirements; power increase testing program; and coolant activity measurements. (D.C.C.)

59943 (DOCKET-50245-95) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Emergency Core Cooling System Conformance to New AEC Adopted Interim Acceptance Criteria. (Northeast Utilities Service Co., Hartford, Conn.). 30 Sep 1971. 36p. Dep. NTIS.

59944 (DOCKET-50245-98) MILLSTONE NUCLEAR POWER STATION, UNIT NO. 1. Statement of Reasons for Non-suspension of Provisional Operating License. (Millstone Point Co., Hartford, Conn.). 19 Oct 1971. 55p. Dep. NTIS.

59945 (DOCKET-50247-51) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Facility Operating License. (Division of Reactor Licensing (AEC), Washington, D. C.). 19 Oct 1971. 9p. Dep. NTIS.

59946 (DOCKET-50247-52) INDIAN POINT NUCLEAR GENERATING UNIT NO. 2. Environmental Report, Suppl. 2. (Consolidated Edison Co. of New York, Inc., New York). 15 Oct 1971. 25p. Dep. NTIS.

Information concerning radioactive discharges from the reactor due to normal and accident conditions is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

59947 (DOCKET-50249-105) DRESDEN NUCLEAR POWER STATION, UNIT 3. Reasons why the Operation of the Unit should not be Limited or Suspended Pending Completion of NEPA Review. (Commonwealth Edison Co., Chicago, Ill.). 18 Oct 1971. 18p. Dep. NTIS.

59948 (DOCKET-50250-50) TURKEY POINT PLANT, UNITS NO. 3 AND NO. 4. Statement Why Construction Permit Should not be Suspended Pending Completion of NEPA Environmental Review. (Florida Power and Light Co.). 18 Oct 1971. 134p. (DOCKET-50251-45). Dep. NTIS.

59949 (DOCKET-50254-53) QUAD-CITIES STATION, UNITS 1 AND 2. Request to Load and Test in View of Impending Power Shortage in 1972. (Commonwealth Edison Co., Chicago, Ill.). 12 Oct 1971. 33p. (DOCKET-50265-45). Dep. NTIS.

59950 (DOCKET-50259-27) BROWNS FERRY NUCLEAR PLANT, UNITS 1, 2, AND 3. State why the Construction of the Station Should not be Interrupted During Prospective Review Period. (Tennessee Valley Authority, Knoxville). 15 Oct 1971. 37p. (DOCKET-50260-26; DOCKET-50296-25). Dep. NTIS.

59951 (DOCKET-50261-74) H. B. ROBINSON UNIT NO. 2. BRUNSWICK STEAM ELECTRIC PLANT UNITS 1 AND 2. Statement why Construction Permits Should not be Suspended Pending Completion of NEPA Environmental Review. (Carolina Power and Light Co., Raleigh, N. C.). 18 Oct 1971. 33p. (DOCKET-50324-23; DOCKET-50325-23). Dep. NTIS.

59952 (DOCKET-50263-86) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Technical Specification Amended

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Change Request No. 2. (Northern States Power Co., Minneapolis, Minn.). 15 Oct 1971. 160p. Dep. NTIS.

Revised technical specifications are presented concerning the gaseous radwaste system. (D.C.C.)

59953 (DOCKET-50263-87) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Statement Why Operating License Should Not be Suspended Pending Completion of the NEPA Environmental Review. (Northern States Power Co., Minneapolis, Minn.). 15 Oct 1971. 159p. Dep. NTIS.

59954 (DOCKET-50266-56) POINT BEACH NUCLEAR PLANT, UNIT 1. Statement Why Operating License Should Not be Suspended Pending Completion of NEPA Environmental Review. (Wisconsin Electric Power Co., Milwaukee). 19 Oct 1971. 192p. Dep. NTIS.

59955 (DOCKET-50267-34) FORT ST. VRAIN NUCLEAR GENERATING STATION, UNIT 1. Statement Establishing That the Station Should Not Be Suspended Pending Completion of Environmental Review. (Public Service Co. of Colorado, Denver). 13 Oct 1971. 25p. Dep. NTIS.

59956 (DOCKET-50271-63) VERMONT YANKEE NUCLEAR POWER STATION. PILGRIM NUCLEAR POWER STATION. MAINE YANKEE ATOMIC POWER STATION. MILLSTONE NUCLEAR POWER STATION. How New England Regional Power Supply Would be Affected by Delay and Shutdown of Nuclear Capacity. (New England Planning Committee. New England Power Exchange, West Springfield, Mass.). 12 Oct 1971. 27p. (DOCKET-50293-55; DOCKET-50309-42; DOCKET-50245-97). Dep. NTIS.

59957 (DOCKET-50272-20) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Statement Why the Construction Permits Should Not be Suspended Pending Completion of the NEPA Environmental Review. (Public Service and Gas Co., Newark, N. J.). 18 Oct 1971. 51p. (DOCKET-50311-20). Dep. NTIS.

59958 (DOCKET-50275-16) DIABLO CANYON NUCLEAR POWER PLANT, UNITS 1 AND 2. Statement Why Construction Permits Should Not be Suspended Pending Completion of NEPA Environmental Review. (Pacific Gas and Electric Co., San Francisco, Calif.). 18 Oct 1971. 25p. (DOCKET-50323-14). Dep. NTIS.

59959 (DOCKET-50277-24) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Statement of Reasons Establishing That Construction Permits Should Not be Suspended Pending Completion of NEPA Environmental Review. (Philadelphia Electric Co., Pa.). 19 Oct 1971. 70p. (DOCKET-50278-24). Dep. NTIS.

59960 (DOCKET-50280 50) SURRY POWER STATION, UNITS NO. 1 AND NO. 2. Final Safety Analysis Report, Amendment No. 26. (Virginia Electric and Power Co., Richmond). 6 Oct 1971. 46p. (DOCKET-50281-48). Dep. NTIS.

Additional information is presented concerning the use of sensitized stainless steel in the piping systems of the Surry Power Reactor Units 1 and 2. (D.C.C.)

59961 (DOCKET-50280-51) SURRY POWER STATION, UNITS NO. 1 AND NO. 2. Request for Additional Information on Plant Construction. (Division of Compliance (AEC), Washington, D. C.). 20 Aug 1971. 8p. (DOCKET-50281-50). Dep. NTIS.

Requests for additional information concerning piping system welds and quality assurance program requirements during construction are presented. (D.C.C.)

59962 (DOCKET-50280-52) SURRY POWER STATION, UNITS 1 AND 2. Sensitized Stainless Steel in Pressurized Water Reactor Applications. (Stone and Webster Engineering Corp., Boston, Mass.). 6 Jul 1971. 62p. (DOCKET-50281-51). Dep. NTIS.

59963 (DOCKET-50282-41) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Statement Why Construction Permits Should Not be Suspended Pending Completion of NEPA Environmental Review. (Northern States Power Co., Minneapolis, Minn.). 15 Oct 1971. 118p. (DOCKET-50306-40). Dep. NTIS.

59964 (DOCKET-50285-49) FORT CALHOUN STATION, UNIT NO. 1. Statement Establishing That the Station Should Not Be Suspended Pending Completion of Environmental Review. (Omaha Public Power District, Nebr.). 14 Oct 1971. 53p. Dep. NTIS.

59965 (DOCKET-50286-39) INDIAN POINT NUCLEAR GENERATING UNIT NO. 3. Statement Why Construction Permit Should Not be Suspended Pending Completion of NEPA Environmental Review. (Consolidated Edison Co. of New York, Inc., New York). 19 Oct 1971. 56p. Dep. NTIS.

59966 (DOCKET-50293-56) PILGRIM NUCLEAR POWER STATION. Preoperational Environmental Radiation Survey Program. Quarterly Report, April 1-June 30, 1971. (ICN/Tracerlab, Waltham, Mass.). 12 Oct 1971. 32p. Dep. NTIS.

For Boston Edison Co., Mass.

59967 (DOCKET-50295-32) ZION STATION, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 16. (Commonwealth Edison Co., Chicago, Ill.). 21 Oct 1971. 175p. (DOCKET-50304-31). Dep. NTIS.

Revised design parameters of the Zion Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

59968 (DOCKET-50301-41) POINT BEACH NUCLEAR PLANT, UNIT NO. 2. Emergency Core Cooling System, Appendix E. (Wisconsin Electric Power Co., Milwaukee). 18 Oct 1971. 5p. Dep. NTIS.

Performance evaluation for the emergency core cooling system under small break conditions is presented. (D.C.C.)

59969 (DOCKET-50302-26) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Statement of Reasons Why Construction Should Not Be Suspended Pending Completion of NEPA Environmental Review. (Florida Power Corp., St. Petersburg). 14 Oct 1971. 55p. Dep. NTIS.

59970 (DOCKET-50305-26) KEWAUNEE NUCLEAR POWER PLANT. Statement Supporting Reasons Why Construction Permit Should Not Be Suspended. (Wisconsin Public Service Corp., Green Bay). 11 Oct 1971. 32p. Dep. NTIS.

59971 (DOCKET-50312-26) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Statement Why the Construction Permit Should Not Be Suspended Pending Completion of the NEPA Environmental Review. (Sacramento Municipal Utility District, Calif.). 19 Oct 1971. 19p. Dep. NTIS.

59972 (DOCKET-50315-48) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 17, Vol. 7. (Indiana and Michigan Power Co., New York). 6 Oct 1971. 171p. (DOCKET-50316-48). Dep. NTIS.

Revised information concerning the waste disposal system is presented. Requested additional data on the reactor cooling system and the containment system are included. (D.C.C.)

59973 (DOCKET-50315-49) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 17, Vol. 8. (Indiana and Michigan Electric Co., New York). 7 Oct 1971. 19p. (DOCKET-50316-49). Dep. NTIS.

Requested additional information is presented concerning the performance of containment systems during accident conditions. (D.C.C.)

59974 (DOCKET-50317-28) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Statement Why Construction Permits Should not be Suspended Pending Completion of NEPA Environmental Review. (Baltimore Gas and Electric Co., Md.). 18 Oct 1971. 135p. (DOCKET-50318-28). Dep. NTIS.

59975 (DOCKET-50317-29) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 14, Revision 3. (Baltimore Gas and Electric Co., Md.). 22 Oct 1971. 29p. (DOCKET-50318-29). Dep. NTIS.

Additional meteorological data for the reactor site are presented. (D.C.C.)

59976 (DOCKET-50321-24) EDWIN I. HATCH NUCLEAR POWER PLANT, UNIT 1. Statement Why Construction Permit Should not be Suspended Pending Completion of NEPA Environmental Review. (Georgia Power Co., Atlanta). 18 Oct 1971. 36p. Dep. NTIS.

59977 (DOCKET-50327-20) SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. Statement Why Construction Permits Should not be Suspended Pending Completion of NEPA Environmental Review. (Tennessee Valley Authority, Knoxville). 15 Oct 1971. 28p. (DOCKET-50328-20). Dep. NTIS.

59978 (DOCKET-50329-27) MIDLAND PLANT, UNITS 1 AND 2. Environmental Report Including Appendixes A-S. (Consumers Power Co., Jackson, Mich.). 19 Oct 1971. 1411p. (DOCKET-50330-26). Dep. NTIS.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Biological data for the reactor site are presented. (D.C.C.)

59979 (DOCKET-50331-28) DUANE ARNOLD ENERGY CENTER. Statement Why Construction Permit Should not be Suspended Pending Completion of NEPA Environmental Review. (Iowa Electric Light and Power Co., Cedar Rapids). 16 Oct 1971. 148p. Dep. NTIS.

59980 (DOCKET-50333-31) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Action Taken to Correct Items of Nonconformance Found on August 16-18, 1971. (Power Authority of the State of New York). 27 Aug 1971. 25p. Dep. NTIS.

Additional information is presented concerning the re-evaluation of the main steam isolation valve discs, the four inch recirculation system bypass valves nondestructive examination, and evaluation of the damage to the reactor pressure vessel nozzle resulting from an in-transit incident. (D.C.C.)

59981 (DOCKET-50333-32) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Statement Why Construction Permits Should not be Suspended Pending Completion of NEPA Environmental Review. (Power Authority of the State of New York). 18 Oct 1971. 51p. Dep. NTIS.

59982 (DOCKET-50334-26) BEAVER VALLEY POWER STATION. Statement Why Construction Permit Should not be Suspended Pending Completion of NEPA Environmental Review. (Duquesne Light Co., Pittsburgh, Pa.). 15 Oct 1971. 34p. Dep. NTIS.

59983 (DOCKET-50335-20) HUTCHINSON ISLAND PLANT, UNIT NO. 1. Statement Why Construction Permit Should not be Suspended Pending Completion of NEPA Environmental Review. (Florida Power and Light Co.). 18 Oct 1971. 73p. Dep. NTIS.

59984 (DOCKET-50336-23) MILLSTONE NUCLEAR POWER STATION, UNIT NO. 2. Statement Why Construction Permit Should not be Suspended Pending Completion of NEPA Environmental Review. (Millstone Point Co., Hartford, Conn.). 19 Oct 1971. 63p. Dep. NTIS.

59985 (DOCKET-50338-32) NORTH ANNA POWER STATION, UNITS 1 AND 2. Reasons Why Construction Permits Should Not Be Suspended Pending Environmental Review. (Virginia Electric and Power Co., Richmond). 11 Oct 1971. 40p. (DOCKET-50339-31). Dep. NTIS.

59986 (DOCKET-50341-34) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Environmental Report, Construction Permit Stage (Revised). (Detroit Edison Co., Mich.). Sep 1971. 176p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

59987 (DOCKET-50346-20) DAVIS-BESSE NUCLEAR POWER STATION. Statement of Reasons Why Construction Permit Should Not Be Suspended Pending Environmental Review. (Toledo Edison Co., Ohio). 15 Oct 1971. 101p. Dep. NTIS.

59988 (DOCKET-50348-27) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 23. (Alabama Power Co., Birmingham). 8 Oct 1971. 10p. (DOCKET-50364-21). Dep. NTIS.

Additional information is presented concerning the use of a runway for aircraft operation on the plant site. (D.C.C.)

59989 (DOCKET-50352-21) LIMERICK GENERATING STATION, UNITS NO. 1 AND NO. 2. Responses to Comments made by Department of the Interior, Fish and Wildlife Service. (Philadelphia Electric Co., Pa.). 5 Oct 1971. 12p. (DOCKET-50353-21). Dep. NTIS.

Requested additional information is presented concerning the effects of reactor operations on ecosystems. (D.C.C.)

59990 (DOCKET-50352-22) LIMERICK GENERATING STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 13. (Philadelphia Electric Co., Pa.). 8 Oct 1971. 59p. (DOCKET-50353-22). Dep. NTIS.

Additional information is presented concerning: radioactive effluents; emergency core cooling system performance; and secondary cooling system. Information requested by the Division of Reactor Licensing is also included. (D.C.C.)

59991 (DOCKET-50363-18) FORKED RIVER NUCLEAR GENERATING STATION, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment 11. (Jersey Central Power and Light Co., Morristown, N. J.). 15 Oct 1971. 358p. Dep. NTIS.

Revised design parameters of the Forked River Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

59992 (DOCKET-50366-16) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 10. (Georgia Power Co., Atlanta). 11 Oct 1971. 94p. Dep. NTIS.

Revised design parameters of the Edwin I. Hatch Power Reactor Unit 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

59993 (DOCKET-50366-17) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment No. 11. (Georgia Power Co., Atlanta). 18 Oct 1971. 114p. Dep. NTIS.

Revised design parameters of the Edwin I. Hatch Power Reactor Unit 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

59994 (DOCKET-50368-17) ARKANSAS NUCLEAR ONE, UNIT 2. Preliminary Safety Analysis Report, Amendment 13. (Arkansas Power and Light Co., Little Rock). 4 Oct 1971. 132p. Dep. NTIS.

Revised design parameters of the Arkansas Nuclear One Power Reactor Unit 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

59995 (DOCKET-50373-10) LA SALLE COUNTY STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 5. (Commonwealth Edison Co., Chicago, Ill.). 8 Oct 1971. 140p. (DOCKET-50374-10). Dep. NTIS.

Revised design parameters of the La Salle County Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

59996 (DOCKET-50382-11) WATERFORD STEAM ELECTRIC STATION, UNITS 3 AND 4. Preliminary Safety Analysis Report, Amendment 6. (Louisiana Power and Light Co., New Orleans). 8 Oct 1971. 338p. (DOCKET-50383-11). Dep. NTIS.

Revised design parameters of the Waterford Power Reactor Units 3 and 4 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

59997 (DOCKET-50382-12) WATERFORD STEAM ELECTRIC STATION, UNITS 3 AND 4. Application Withdrawn. (Louisiana Power and Light Co., New Orleans). 19 Oct 1971. 1p. (DOCKET-50383-12). Dep. NTIS.

59998 (DOCKET-50387-10) SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 1. (Pennsylvania Power and Light Co., Allentown). 12 Oct 1971. 184p. (DOCKET-50388-10). Dep. NTIS.

Revised design parameters of the Susquehanna Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

59999 (DOCKET-50387-11) SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment No. 2. (Pennsylvania Power and Light Co., Allentown). 15 Oct 1971. 74p. (DOCKET-50388-11). Dep. NTIS.

Requested additional data on the reactor concerning design parameters and operation aspects are presented. (D.C.C.)

60000 LEAK RATE TEST ON NUCLEAR REACTOR CONTAINMENT VESSEL FOR NO. 1 UNIT OF MIHAMA POWER STATION, KANSAI ELECTRIC POWER CO., INC. Kaneda, A. (Mitsubishi Heavy Industries, Ltd., Tokyo); Kamisako, M.; Masaki, T.; Katayama, M.; Satake, M. Mitsubishi Juko Giho; 8: No. 3, 427-38(May 1971). (In Japanese).

Leak rate test was conducted on the No. 1 nuclear reactor containment vessel installed in the Mihama Power Station as its preoperational test. This is the first test in Japan approved to be performed by the absolute method on the basis of the test results

XUM

obtained at the time of completion of the vessel. The details of the test are described. As the result of the test, it was confirmed that the leak rate of the containment vessel at the design pressure (2.39 kg/cm^2G) was about 0.02%/24 h, which was far less than the allowable leak rate of 0.1%/24 h. It was also found that because the containment vessel is surrounded by an exterior shield concrete wall, there was a great error in the leak rate when it was heated from above during daytime, the error could be eliminated effectively by spraying water on the top of the vessel and also that leak rate could be calculated with sufficient accuracy by using the measured values during midnight to dawn, in which case spraying of water was not necessary. (auth) (Japan)

60001 NUCLEAR POWER: RISKS AND SOCIAL CONCERNS. Tsivoglou, Ernest C. (Georgia Inst. of Tech., Atlanta). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 19-27(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The conflict between the nuclear power industry and the conservationists concerning the development of nuclear power plants is discussed. The problems of radioactive waste and thermal effluents are studied. Suggestions for safe development and operation of nuclear power plants are presented. 11 references. (D.C.C.)

60002 NUCLEAR POWER: SOCIAL NEEDS AND BENEFITS. Jordan, Walter H. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 28-30(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The demands for electric power in the U. S. are discussed. The merits of building nuclear power plants to meet the demands are presented. The environmental effects of nuclear and fossil fuel plants are compared. 4 references. (auth)

60003 ECONOMIC VS BIOLOGICAL RISK AS REACTOR DESIGN CRITERIA. Otway, Harry J. (Los Alamos Scientific Lab., N. Mex.); Burnham, John B.; Lohrding, Ronald K. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 451-4(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The economic risk to the power plant operator and the biological risk to the public health are compared as design criteria for determining the reliability required of reactor systems. When only the large-scale Design Basis Accident was considered for a 1000 MW(e) PWR, the biological risk was found to be the controlling risk. However, when the entire spectrum of accidents which would cause external release of fission products was considered, the economic loss to the reactor operator seemed disproportionately large when compared to the biological risk. 7 references. (auth)

60004 PUBLIC PARTICIPATION IN LOCATING FACILITIES. Nassikas, John N. Pub. Util. Fortn.; 88: No. 6, 108-14(16 Sep 1971).

The legal procedures for public participation in regulatory proceedings on the siting of new utility facilities in the United States are briefly reviewed. (H.D.R.)

Power Reactor Development

Refer also to abstract 58331.

60005 (ANL-7854) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT, AUGUST 1971. (Argonne National Lab., Ill.). 23 Sep 1971. Contract W-31-109-eng-38. 165p. Dep. NTIS.

Highlights of project activities for August 1971 are summarized. The EBR-2 operations, fission product monitoring instruments, data acquisition system, and physics measurements are described. Heat transfer and fluid flow studies for LMFBR safety aspects are reviewed. FFTF and LMFBR instrumentation development is described. Monitoring and sampling systems for liquid sodium are discussed. Performance characteristics of LMFBR fuel elements are analyzed. Physics measurements in the ZPR-6, ZPR-9, and ZPPR are presented. Reprocessing methods for LMFBR fuels are discussed. LMFBR safety studies and TREAT operations are described. (D.C.C.)

60006 (CONF-700113) PROCEEDINGS OF THE SEMINAR ON NUCLEAR POWER, BOMBAY, JANUARY 17-18, 1970. Rastogi, B. P. (ed.) (Department of Atomic Energy, Bombay (India)). 313p.

Included are 17 papers on the present potential and the future prospects of nuclear power. A separate abstract was prepared for each of 6 papers. The remaining 11 papers were previously abstracted for NSA and may be located under CONF-700113 in the Report Number Index. (H.D.R.)

For abstracts of individual papers see: 59890-59892 and 60017-60019.

60007 (CONF-710922-1) SOME IDEAS ON THE EXPERIENCE GAINED DURING THE CONSTRUCTION OF FAST BREEDER REACTORS. Carle, Remy (Commissariat a l'Energie Atomique, Paris (France)). [nd]. 11p.

From International conference on fast reactors; Aix-en-Provence, France (2 Sep 1971).

Some of the unique construction requirements and problems of sodium cooled fast breeder reactors are discussed, with particular emphasis on experience with the Phenix Fast Reactor. (H.D.R.)

60008 (CONF-710922-4) BASIC PROBLEMS OF THE DEVELOPMENT OF FAST BREEDER REACTORS. Haefele, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). [1970]. 24p. Dep. NTIS (U. S. Sales Only).

From International conference on fast reactors; Aix-en-Provence, France (2 Sep 1971).

A number of basic problems of fast reactor development are reviewed. Burnup, stainless steel swelling, short neutron lifetime, Doppler effect, Na void effect and the choice of coolants are discussed. The problem of Pu fuel fabrication costs and the pool-loop problem are studied. 37 references. (auth)

60009 (CONF-710922-5) GAS COOLED FAST BREEDER REACTOR. Rickard, C. L. (Gulf General Atomic, Inc., San Diego, Calif.). [nd]. 5p.

From International conference on fast reactors; Aix-en-Provence, France (2 Sep 1971).

The development of gas-cooled fast breeder reactors is reviewed. Design problems associated with gas-cooled fast breeder reactors are described. (D.C.C.)

60010 (EURFNR-902) FAST BREEDER PROJECT. Fourth Quarterly Report 1970. (Kernforschungszentrum, Karlsruhe (West Germany)). Translation of report KFK-1270/4. 134p. Dep. NTIS.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

REACTOR FUEL ELEMENTS—development of fast breeder, fabrication and irradiation testing programs for
—cladding materials for fast breeder, development of, (E/T)
REACTOR FUELS—development of fast breeder, fabrication and irradiation testing programs for
REACTORS, BREEDER—development in Germany during October to December 1970
—physics parameters of, (E/T)
—safety studies on, (E/T)
—core monitoring in, instrumentation and signal processing for, (E/T)
—cooling systems for, corrosion product and fission product activity levels in, (E)
REACTORS, FAST—development in Germany during October to December 1970
—physics parameters of, (E/T)
—safety studies on, (E/T)
—core monitoring in, instrumentation and signal processing for, (E/T)
—cooling systems for, corrosion product and fission product activity levels in, (E)
—core for, hydrodynamic and thermodynamic design of, (E/T)
REACTORS, RESEARCH—core design for FR-3
SODIUM—corrosive effects of liquid, on fast breeder reactor materials, (E/T)

60011 (JAERI-Memo-4419) PRELIMINARY DESIGN OF THE EXPERIMENTAL MULTI-PURPOSE HIGH TEMPERATURE REACTOR. (Japan Atomic Energy Research Inst., Tokyo). May 1971. 338p. (In Japanese and English). Dep. NTIS (U. S. Sales Only).

A preliminary design of the 50 MW(t) Experimental Multi-Purpose High Temperature Reactor is described. The basic concepts adopted in this design are (a) fuel kernels of UO_2 with low enriched uranium, (b) coated fuel particles with triple barrier coatings including SiC, (c) block-type fuel elements with hollow rod fuel pins, (d) three coolant loops including a closed gas turbine loop and two loops of methane steam reformer with successive coupling of the steam generator, and (e) reactor outlet coolant helium temperature of 1000°C and inlet temperature of

XUM

400°C. From this design work, it has been found that the maximum fuel temperature is about 1350°C and that the hydrogen permeation problem from the secondary coolant system can be solved in a reasonable way. It is also pointed out what are the subjects of research and development to be made to facilitate the design. This is the second stage of design evolution of the reactor and is to be followed by the conceptual (3rd stage) design and the detailed (4th stage) design. (auth) (Japan)

60012 (JUL-775-RG) TECHNICAL AND SCIENTIFIC POSITION AS WELL AS PROSPECT FOR NUCLEAR ENERGY IN THE ENGINEERING OF THE FEDERAL REPUBLIC OF GERMANY. PART II. Haefele, W.; Kraemer, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorentwicklung. Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Jun 1971. 78p. (In German). (KFK-1430). Dep. NTIS (U. S. Sales Only).

The present state of the German atomic program is surveyed with respect to support of advanced reactor lines, namely high-temperature reactors and sodium-cooled fast breeders. Results of developmental work as well as problems and challenges are discussed from a technological as well as economical standpoint. As far as fast breeders are concerned, construction and successful operation of SNR 300 has greatest priority including development of the large sodium components by private industry. Also important is development of production facilities for plutonium-containing fuel elements. During construction of the SNR 300, an attempt should be made, as a collective European effort, at development of a commercial SNR 1000. Discussion of basic processes includes fuel elements, reactor safety, helium- and steam cooling of fast breeders, and reprocessing. 61 references. (H.B.G.)

60013 (KFK-1375) GAS BREEDER-MEMORANDUM. RESULTS OF AN INVESTIGATION OF THE FEASIBILITY AND ECONOMICS OF A GAS-COOLED FAST BREEDER. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Feb 1971. 502p. (In German). (EUR-4575; JUL-744-RG). Dep. NTIS (U. S. Sales Only).

The feasibility and the economics of a gas-cooled fast breeder (GCFB) are studied. This study has been initiated to determine what measures should be taken in the event that the sodium-cooled fast breeder would not fulfill its technical and economic expectations. The design of a GCFB could, to a great extent, be based on known techniques. The experience gained, especially with the construction and operation of gas-cooled thermal reactors, could be used. Contrary to the steam-cooled breeder reactor, the GCFB has favorable breeding properties and its potential as regards fuel consumption is close to the sodium breeder. Topics discussed include: fuel elements; physical criteria; components; safety; and economics. 20 references. (auth)

60014 (ORNL-4676) MOLTEN-SALT REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING FEBRUARY 28, 1971. (Oak Ridge National Lab., Tenn.). Aug 1971. Contract W-7405-eng-26. 277p. Dep. NTIS.

Activities directed to the development of a single-fluid molten salt breeder reactor are reported. Sections are included on: (1) Molten-Salt Reactor Experiment; (2) MSBR design and development; (3) chemistry; (4) materials development; and (5) Molten-salt processing and preparation. A separate abstract was prepared for each of the 5 sections. (H.D.R.)

For abstracts of individual sections see: 57298, 57522, 58168, 60015, and 60096.

60015 (ORNL-4676, pp 21-72) MSBR DESIGN AND DEVELOPMENT. (Oak Ridge National Lab., Tenn.). Aug 1971.

In Molten-Salt Reactor Program semiannual progress report for period ending February 28, 1971.

BERYLLIUM FLUORIDES—$BeF_2-LiF-ThF_4-UF_4$, heat transfer and thermophysical properties of, (E/T)
CORROSION LOOPS—inspection of sodium fluoroborate salt, postoperation
HIGH-TEMPERATURE LATTICE TEST REACTOR—physics measurements on molten salt reactor lattices in
LITHIUM FLUORIDES—$BeF_2-LiF-ThF_4-UF_4$, heat transfer and thermophysical properties of, (E/T)
MOLTEN SALT BREEDER EXPERIMENT—design parameters of
MOLTEN SALT BREEDER EXPERIMENT—fission product removal from fuel salt in, performance of gas separators and bubble generators for, (E)
MOLTEN SALT BREEDER REACTOR—steam generator for, hybrid computer simulation model of
—fuel salt for, heat and mass transfer and thermophysical properties of, (E/T)
—design of single fluid 1000 MW(e)
—heat exchangers for, shutdown temperature transients in empty, (T)
—heat exchangers for, effects of tubing failures in, (T)
—tritium distribution and control in, (T)
—physics analysis of single fluid 1000 MW(e)
MOLTEN SALT REACTOR EXPERIMENT—fuel salt for, postoperation inspection of Mark 2 pump for
—coolant salt for, postoperation inspection of pump for
REACTORS, MOLTEN SALT—maintenance of, development of remote welding for
—design parameters of 300 MW(e) demonstration
THORIUM FLUORIDES ThF_4—$BeF_2-LiF-ThF_4-UF_4$, heat transfer and thermophysical properties of, (E/T)
URANIUM FLUORIDES UF_4—$BeF_2-LiF-ThF_4-UF_4$, heat transfer and thermophysical properties of, (E/T) (H.D.R.)

60016 NUCLEAR REACTOR INSTALLATIONS. (to Siemens Aktiengesellschaft). British Patent 1,245,007. 2 Sep 1971. Priority date 13 Oct 1967, Germany.

REACTORS, GAS COOLED—design with direct cycle carbon dioxide turbines (H.D.R.)

60017 COMMENTS ON THE ROLE OF CONTRACTING IN THE DEVELOPMENT OF ATOMIC ENERGY IN THE UNITED STATES. Erlewine, John T. (Atomic Energy Commission, Washington, D. C.). pp 191-8 of Proceedings of the Seminar on Nuclear Power. /Rastogi, B. P. (ed.). Bombay; Department of Atomic Energy (1970).

From Seminar on nuclear power; Bombay, India (17 Jan 1970).

The development of nuclear power is of special interest and importance throughout the world. However, it is evident that actual achievement of this potential through the development of nuclear power to the point where it contributes in a substantial way to the lives and welfare of the citizens of any country is a challenging task fraught with many problems, not all of which are scientific or technical in nature. How contracting was used in the United States as a tool of management in solving some of the non-technical problems in developing a commercial nuclear power industry is described. (auth)

60018 NATIONAL NUCLEAR CENTRES IN DEVELOPING COUNTRIES. Sethna, H. N. (Indian Atomic Energy Commission, Bhabha). pp 199-210 of Proceedings of the Seminar on Nuclear Power. /Rastogi, B. P. (ed.). Bombay; Department of Atomic Energy (1970).

From Seminar on nuclear power; Bombay, India (17 Jan 1970).

Developing countries which for economic reasons wish to develop nuclear power and use nuclear energy for peaceful purposes are faced with the problem of the creation of a cadre of scientific and technical personnel who could provide the necessary guidance. The problem could nevertheless be handled by setting up a national complex for research and development. This in its turn requires a substantial financial and technical investment, paucity of which is the main handicap of developing countries. The methodology of expansion of activities and the growth of this center are described. (auth)

60019 STATUS OF HEAVY WATER MODERATED REACTOR. Haywood, L. R. (Chalk River Nuclear Labs, Ont.). pp 225-39 of Proceedings of the Seminar on Nuclear Power. /Rastogi, B. P. (ed.). Bombay; Department of Atomic Energy (1970).

From Seminar on nuclear power; Bombay, India (17 Jan 1970).

The worldwide status of heavy water moderated power reactors is briefly summarized. The Canadian reactor program is described, and development programs for fuels, coolants, materials, fuel reprocessing, heavy water production, and mechanical equipment are discussed. (H.D.R.)

60020 NUCLEAR ENERGY RESERVES AND LONG-TERM ENERGY REQUIREMENTS. Zimen, K. E. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Angew. Chem. Int. Ed. Engl.; 10: No. 1, 1-11(Jan 1971).

The world's potential energy reserves are summarized on the basis of available estimates, and the future energy consumption is estimated with the aid of a working hypothesis relating to the growth of the world's population (P) and the energy consumption per capita (γ). According to this estimate, the energy requirements in 30 years will be about seven times and in 80 years about fifty times as high as they are today, and all the concentrated energy sources will be exhausted in about 120 to 160 years. The energy requirements in the steady state ($P\gamma$ = const.) could be of the order of 10^{13} MWh per year and could be met out of magmatic rocks (U,Th) and seawater (U,D). High priority should be given to research and development work on the construction, reliability,

XUM

and safety of breeder and fusion reactors, the chemical treatment and final disposal of radioactive waste, the extraction of uranium, thorium, and deuterium from the "primitive" raw materials, the relevant problems relating to protection of the environment, and the worldwide control of the excess birthrate. (auth)

60021 SEALING ARRANGEMENT FOR ROTATABLE MEMBERS. **(to Interatom, Internationale Atomreaktorbau GmbH). British Patent 1,245,218. 8 Sep 1971. Priority date 26 Apr 1969, Germany.**

REACTORS, LIQUID METAL COOLED—core vessels for sodium cooled, sealing means for rotatable covers on
SEALS AND GLANDS—design characteristics for rotatable cover, for liquid metal cooled reactor core vessels
VESSELS—seals for rotatable covers of liquid metal cooled reactor core (H.D.R.)

60022 MEASUREMENT OF RADIATION HEAT RELEASE VALUE IN STRUCTURAL AND MODERATING MATERIALS OF REACTOR IVV-2. Gerasimenko, V. P.; Goshchitskii, B. N.; Gusev, V. V.; **(and others). At. Energ. (USSR); 31: No. 1, 7-11(Jul 1971). (In Russian).**

With the quasi-adiabatic and isothermic calorimeters the values of radiation heat release were measured in some structural and moderating materials of the reflector and the core of the water cooled and moderated reactor IWW-2. The results, obtained by both methods, coincide within limits of 10 to 15% and are close to the results of calculations, based on simple assumptions about the γ- and fast neutron spectra. It is shown that a lead screen 20 mm thick almost completely eliminates the γ-component of radiation heat release in hydrogenous moderators and reduces it in aluminum approximately 2.5 times. (auth)

60023 SPINNING DISCS: A BETTER WAY TO COOL POND WATER? Papamarcos, John. Power Eng.; 75: No. 9, 54-7 (Sep 1971).

A demonstration project to investigate the effectiveness of a spinning disc spray system for power plant cooling ponds is described. The basic system consists of 24 inch by $\frac{1}{4}$ inch discs mounted on shafts floating on the pond. Electric motors drive the shafts to produce spray when the discs spin. Nine prototype units are being tested in the demonstration project. (H.D.R.)

60024 NUCLEAR POWER ABROAD: A TIME OF CHANGE. **Loftness, Robert L. Combustion; 43: No. 2, 12-17(Aug 1971).**

National efforts to achieve independence in the field of nuclear energy and changes in the direction of development activities due to changing economic factors are discussed. Broad changes include the shift to the most economic reactor types, increased emphasis on independent uranium enrichment facilities, engineering development from an industrial base instead of in national laboratories, and the formation of national and international consortia. (H.D.R.)

60025 PHENIX REACTOR. CIVIL ENGINEERING ON THE PHENIX SITE. Labat, P. **(Groupement Atomique Alsacienne Atlantique, Le Plessis-Robinson, France); Gregut, A. Energ. Nucl. (Paris); 13: No. 3, 213-17(May 1971). (In French).**

The civil engineering and erection work carried out on the Phenix power reactor site since the spring of 1968 is described. Site preparation, the main substructure excavation, and the foundation and erection work are discussed. (France)

60026 DESIGN FOR ACCESS AND INSPECTION IN GAS-COOLED REACTORS. Wright, R. F. **(British Nuclear Design and Construction Ltd., Whetstone, Eng.); Jones, G. H. pp 57-69 of Active Working on Reactors. London; British Nuclear Energy Society (1971).**

From Meeting on active working on reactors; London, England (1 Oct 1970). See CONF-701054.

The requirements for access and inspection remain various. The nature of unscheduled happenings on power reactors has been most individual in character. The evolution of a design approach for access and inspection has not been easy. An attempt is made to identify three principal areas of significance and to identify issues for further attention. (auth) (UK)

60027 HEAT ENGINE PLANT. **Coast, Geoffrey; Morgan, Vernon (to United Kingdom Atomic Energy Authority). British Patent 1,245,971. 15 Sep 1971. Filed 19 Jan 1968.**

Reference is made to a plant in which heat energy is conveyed by means of a compressible fluid from a heat source, such as a nuclear reactor, to an energy converter such as a gas turbine. Thermal efficiencies of the order of 40% can be obtained from such a plant, but such high efficiency in conventional plants entails complexity in design. There is a pressure limitation on the circuit imposed by the reactor, and this must be offset in some way if high efficiency is to be obtained. The closed circuit system described comprises the following components arranged in sequence in the direction of flow: a compressor, the heat output side of a regenerative heat exchanger, a heat source (nuclear reactor), a machine for converting heat energy to mechanical energy (gas turbine), the heat input side of the heat exchanger, and residual heat energy utilization means. The latter allows more than 16% utilization of the heat energy output from the heat source. The total thermal efficiency can be more than 40%, and is obtainable without undue complexity. The working fluid may be CO_2 or He. Freon may be used in a second turbine system for utilizing the residual heat energy. (UK)

60028 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. **(to Babcock and Wilcox Co.). British Patent 1,245,757. 8 Sep 1971. Filed 1 Nov 1968.**

The reactor described employs parallel fuel pins passing through the core to form three zones, the two outer parts of each pin containing blanket material and the central part containing fissile material. The pins are of non-uniform cross section, with maximum cross section in the central zone, to give a maximum coolant velocity in that zone. Satisfactory heat transfer can be obtained by subdividing the pins into a limited number of axial portions each having a fixed diameter. The reduction in coolant flow path area through the central region of the core in addition to giving a greater concentration of pumping power through the hottest part, also minimizes the core volume fraction allocated to coolant flow. A low coolant volume fraction tends to make the core somewhat safer in the event of a coolant loss accident, particularly in the case of steam cooled fast breeder reactors, and also improves the overall efficiency and breeding ratio. (UK)

60029 POWER FROM THE FAST BREEDER. **Hamilton, David. New Sci. Sci. J.; 51: No. 766, 453-5(26 Aug 1971).**

It is stated that in Britain, a commercial fast reactor power station can be in operation before 1980, the compelling reason for its use being its excellent fuel economy. In addition, it is fueled with Pu and "breeds" Pu from ^{238}U, creating a surplus for the first fuel charge of other fast breeder reactors. The advantages of this reactor are very clear, although by 1966 only America, Russia and Britain had experimental fast reactors, the latter concentrating on problems of fuel reprocessing, heat transfer, fuel design and component development. The danger is that the chain-reaction can easily run-away, creating a supercritical mass which would eventually be blown apart. The handling of liquid Na at temperatures of 500°C or more poses another problem, but the reactor has special safety features. The nuclear industry still faces extensive development work, but seven fast reactors are in operation around the world, five are being built, and six more are planned. It is only by running them that the true reliability and economic value of fast reactors can be found. (UK)

60030 WHITHER NUCLEAR POWER? Booth, E. S. (Central Electricity Generating Board, London). Proc. Inst. Elec. Eng. (London); 118: No. 9, 1215-26(Sep 1971).

A broad examination of the likely role of nuclear power in relation to other sources of primary energy for electricity generation in the U.K. is given, and the historical reasons for the choice of different types of reactors in various countries are reviewed. The design and operational performance of the Mk I gas-cooled-reactor stations (Magnox) of the U. K.'s first nuclear-power program are fully discussed. An account of the progress to date in the design and construction of the Mk II gas-cooled-reactor stations (a.g.r.) of the second nuclear-power program and a description of the a.g.r. system is given. Basic descriptions are given of the more advanced types of thermal-reactor systems available for large-scale application and from which a successor or concomitant to the a.g.r. may be chosen, namely the Mk III gas-cooled reactor, also known as the high-temperature reactor (h.t.r.), and the steam-generating heavy-water reactor (s.g.h.w.r.), and also of the type which should become available for commercial exploitation within a few years, the fast-breeder reactor. The dilemma facing the CEGB in the immediate future before deciding on which more advanced reactor type to adopt is considered. The advantages and disadvantages of the four options open to the CEGB—choice of the h.t.r.s.g.h.w.r. or a light-water reactor, or adherence to the a.g.r.—are explained. The cost of introducing a more advanced reactor system can be so great that the case for internationally financed launching programs is indisputable. In spite of the present uncertainties about the direction of nuclear power, there is no dilemma about the merit of nuclear power for electricity generation in the long term. (auth) (UK)

60031 METHOD OF EXCHANGING THE MODERATOR AND FUEL OF A NUCLEAR REACTOR, AND REACTOR EMPLOYING

THE METHOD. (to Brown, Boveri and Co. Ltd.). British Patent 1,246,760. 22 Sep 1971. Priority date 11 Sep 1969, Switzerland.

REACTOR LOADING MACHINES—design characteristics of high temperature gas cooled graphite moderated reactor
REACTORS, GAS-COOLED—loading machine for high temperature graphite moderated
REACTORS, GRAPHITE-MODERATED—loading machine for high temperature gas cooled (D.C.C.)

60032 DEVELOPMENT OF BREEDER REACTORS IN THE EUROPEAN COMMUNITY. De Heem, L. (Societe pour la Coordination de la Production et du Transport de l'Energie Electrique, Brussels). Elec. Rev.; 189: No. 9, 299-300(Aug 1971).

A brief summary is given of the fast reactor programs of the countries of the European Communities. It includes an outline of the work of the Committee of the International Union of Producers and Distributers of Electrical Energy (UNIPEDE) and of the Euratom Commission, in assisting with fast reactor policy and development. (UK)

60033 IMPROVEMENTS IN HEAVY-WATER MODERATED POWER REACTORS. (to Japan Atomic Energy Research Inst.). British Patent 1,248,295. 29 Sep 1971. Priority date 5 Mar 1968, Japan.

REACTORS, HEAVY WATER MODERATED—design of water cooled pressure-tube, with increased core power density
REACTORS, WATER COOLED—design of heavy water moderated pressure-tube, with increased core power density (H.D.R.)

Kinetics and Dynamics

Refer also to abstracts 60159 and 60240.

60034 (AE–428) INTEGRAL MEASUREMENT OF FISSION-PRODUCT REACTIVITY WORTHS IN SOME FAST REACTOR SPECTRA. Andersson, T. L. (Aktiebolaget Atomenergi, Studsvik (Sweden)). Aug 1971. 35p. Dep. NTIS (U. S. Sales Only).

The reactivity worth per atom for a number of fission-product isotopes relative to that of ^{235}U was measured in three fast-reactor spectra. The following isotopes were studied: ^{95}Mo, ^{97}Mo, ^{99}Tc, ^{101}Ru, ^{102}Ru, ^{104}Ru, ^{103}Rh, ^{133}Cs, ^{147}Pm and ^{149}Sm. A fission product mock-up sample was also included in the measurements. The reactivity worths were measured by the pile-oscillator technique. The fundamental mode amplitude of the perturbation signal was obtained through Fourier analysis. The experimental results are compared with calculated values obtained from perturbation calculations using the fission product cross sections available in the SPENG data library. From a comparison between the measured and the calculated reactivity worths it is concluded that only the ^{95}Mo, ^{104}Ru, and ^{149}Sm worths are well predicted in all three systems. For the other samples the calculated values are generally too high. The fission product cross section data in the SPENG data library are compared with corresponding data from the UK Nuclear Data File ND 5066. Considerable discrepancies exist between the two data sets. A separate set of reactivity worth calculations was performed using the Integral Transport Perturbation Programme developed by E. A. Fischer. The calculated results do not differ from those obtained with our own perturbation programme with more than 4% for any of the samples. 21 references. (auth)

60035 (ANL–7824) CHEMICAL ENGINEERING DIVISION. CROSS SECTIONS AND BURNUP SEMIANNUAL REPORT, JANUARY–JUNE 1971. Larsen, R. P.; Dudey, N. D.; Fluss, M. J.; Heinrich, R. R.; Malewicki, R. L.; Oldham, R. D.; Popek, R. J.; Williams, J.; Crouthamel, C. E.; Vogel, R. C. (Argonne National Lab., Ill.). Aug 1971. Contract W-31-109-eng-38. 15p. Dep. NTIS.

Research and development efforts of the cross sections and burnup programs are reported for the period January to June 1971. Work was done in the following areas: measurements of fast-neutron fission yields of gamma-active fission products were made on samples of uranium and plutonium irradiated in the ZPR-3 critical facility, feasibility studies of two independent methods for measuring the fast-neutron tritium yields from heavy-element fission were carried out and preliminary results for ^{235}U were obtained, a five-year program was concluded in which capture-to-fission ratios were determined for uranium and plutonium isotopes irradiated throughout the core and blankets of EBR-II, and fission-rate and activation-rate measurements were made in four mockup configurations of EBR-II in the ZPR-3 critical facility. 5 references. (auth)

60036 (EURFNR–945) CHECK OF NUCLEAR DATA AND METHODS OF CALCULATION BY INTEGRAL EXPERIMENTS. Kiefhaber, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Jun 1971. 70p. (KFK–1422). Dep. NTIS (U. S. Sales Only).

Work performed under United States–Euratom Fast Reactor Exchange Program.

Calculations concerning integral experiments in fast zero power assemblies are discussed. By comparing calculated and measured quantities the nuclear data and methods of calculations used are examined to get indications for further improvements. Following a few introductory remarks some comments to the state of the art of the physics prediction for fast reactors are given. Then the activities at Karlsruhe to improve the nuclear data and methods of calculation, especially some of the most recent results, are described. At first the improvements in the group constant sets are considered and the influence of the energy dependence of the fission spectrum is studied. It is outlined that the proper treatment of relatively thin reflecting zones is difficult in the present scheme of calculations even if a more appropriate type of transport cross section is used. For the SUAK-assemblies the influence of an uncertainty in the enrichment on the criticality is determined. The criticality effect of using the P1-approximation for the scattering on hydrogen instead of the transport approximation is studied for SUAK UH1B and SNEAK 3A2. The difficulties concerned in the calculation of material worths and neutron life time are discussed. The theoretical results obtained at Karlsruhe for the Doppler effect seem to be satisfactory at the moment. The influence of the model used for the calculation of reaction rates and cell traverses for heterogeneous platelet-arrangements is studied and the experimental and theoretical results for the cell traverses are compared. The measured and calculated reaction rate traverses through core and blanket of SNEAK 3A2 are also compared with special emphasis on heterogeneity effects in the core-blanket transition region. Some comments are devoted to the significance of adjustment procedures for group constants. 50 references. (auth)

60037 SOME PROPERTIES OF BOILING-WATER REACTOR SELF-OSCILLATION CONDITIONS. Kebadze, B. V.; Plyutinskii, V. I. At. Energ. (USSR); 31: No. 2, 89-92(Aug 1971). (In Russian).

The results of natural circulation boiling-water-reactor self-oscillation conditions are presented. The character of dependence of oscillation amplitude upon power, pressure and other plant parameters requires an accurate examining of the expected operating conditions and transient processes near the stability limit position. Plant dynamics study in the frequency domain illustrates an oscillation destabilizing effect upon low frequency processes which gives rise to oscillation amplitudes and plant slow parameters cyclic changes. 5 references. (auth)

60038 THERMAL AND HYDRODYNAMIC TRANSFER FUNCTIONS OF BWR CORE. Kagawa, Tatsuo; Yanai, Ryoichi; Ishizuka, Takao (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Toshiba Rebyu; 26: No. 5, 660-5(May 1971). (In Japanese).

The power-to-void transfer function in the boiling channel, which is very important in calculating the kinetic behavior of BWR cores, was measured by the frequency response method using a high-pressure test loop, under the same thermal and hydrodynamic conditions as those of the core (70 kg/cm^{2}a, 284°C). The Jones analytical method was simplified and applied to the test loop for comparative investigation of measurements and calculations. It was found that the calculations well predict measurements qualitatively, and that, particularly when the boiling part occupies most of the test section, calculations come also quantitatively close to measurements. Thus calculation has proved utilizable for presuming reactor characteristics, except for the case with small boiling. (auth) (Japan)

60039 FAST NEUTRON REACTOR PHENIX. Carle, T.; Moreau, J. C.; Megy, J. (CEN de Saclay, Gif-sur-Yvette, France). Energ. Nucl. (Paris); 13: No. 2, 172-5(May 1971). (In French).

The role of Phenix in the development program for fast reactors is reviewed. The various decisions taken in the preliminary plan are indicated together with a description of the reactor and the principal data. The present level of progress and future developments are indicated. (France)

60040 REACTOR PHYSICS HETEROGENEOUS METHODS DEVELOPED AT CISE. PART 1. Bruschi, C.; Caimmi, G. F.; Fava, L.; Goldaniga, G. (CISE, Milan). Energ. Nucl. (Milan); 18: No. 9, 459-72(Sep 1971).

The work done at CISE in the field of heterogeneous methods is reviewed. Such methods were studied to evaluate the hetero-

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geneous effects in the CIRENE reactor. The approximation presented is limited to a monopole formalism, and is in many respects rather conventional. However three points are worth mentioning, namely: (a) the approach to the calculation of the heterogeneous parameters; (b) the auxiliary source technique employed to take the radial finiteness of the core into account; (c) the technique used to ensure spectrum consistency between the parameter and the core calculations. The core calculation is two-dimensional in the radial plane, the finite height of the elements being accounted for by an axial buckling. (auth)

60041 SPATIAL EFFECTS IN TRANSFER-FUNCTION MEASUREMENTS OF LARGE NUCLEAR REACTOR POWER SYSTEMS. Habegger, L; Hsu, C. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 418-25(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The importance of spatial effects in proposed transfer-function measurements in large, fast reactors was investigated. A general theoretical formulation of space-dependent transfer-functions is derived which includes the effects of input and output device spatial characteristics. A quantitative indication of spatial effects is given by numerical simulation of measured transfer-functions in a Liquid Metal Fast Breeder Reactor (LMFBR). An approximate method of solution using the Galerkin's procedure was developed in conjunction with the investigation. 9 references. (auth)

60042 PARAMETER IDENTIFICATION IN A NONLINEAR REACTOR SYSTEM. Roman, William S.; Hsu, Chun; Habegger, Loren J. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 426-9(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Identification of plant parameters in a nonlinear space-dependent reactor system based on simulated measurements has been accomplished. The quasilinearization iterative technique provides the computational capability for solving the nonlinear equations in the identification process. Examples of the identification of feedback temperature coefficients in one and two neutron energy group nonlinear models with linear temperature feedback are presented. 6 references. (auth)

60043 PRECISION OF SHUTDOWN MARGIN MEASUREMENTS USING THE TWO-FREQUENCY REACTOR NOISE TECHNIQUE IN AN LMFBR. Buhl, A. R.; Ackermann, N. J. Jr. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 430-4(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The precision of reactor noise techniques for measuring subcritical reactivity can be related to detector efficiency and parameters of the measuring instrumentation. Using a two-detector cross-correlation technique, it is determined that such measurements can be made in a certain fast reactor (the FFTF) to −3 to −5 dollars with acceptable statistics and measurement times. 8 references. (auth)

60044 POWER SHIFT PHENOMENA IN LARGE FAST BREEDER REACTORS. Philbin, Jeffrey Stephen. Urbana, Ill.; Univ. of Illinois (1971). 100p. University Microfilms Order No. 71-21,210.

Thesis.

A method for accurately analyzing the changes in the neutronic characteristics of large fast reactors during long-term operation is developed. The non-uniform buildup and depletion of the fuel nuclides is taken into account by using eigenfunction expansions in the solution of the one-dimensional, multigroup diffusion equations. A refueling scheme is introduced in order to study the behavior over many reloading cycles as well as between two loading events. The depletion of fissile nuclides in the core and the buildup of fissile nuclide in the blanket cause a power shift into the blanket. The effect of this power shift upon the multiplication factor, the breeding ratio, the power density, and the reactivity coefficients of a large mixed oxide fast reactor is explored in detail. The power shift into the blanket during the approach to equilibrium is 1.55% of the total reactor power. The breeding ratio increases only slightly during reactor operation. The sodium void coefficient increases by 11.2% from startup to the end of an equilibrium period. The Doppler coefficient, which changes only slightly during the approach to equilibrium, becomes more negative. The total change in the Doppler coefficient is 1.71%. (Diss. Abstr. Int., B)

Control Systems

Refer also to abstract 57898.

60045 STABILIZATION OF THE HEAT-OUTPUT FIELD IN FAST REACTORS BY CONTROL ELEMENTS. Usynin, G. B.; Shibaev, V. A.; Chirkov, V. A. At. Energ. (USSR); 31: No. 1, 3-6(Jul 1971). (In Russian).

The effect of the neutron-absorbing control rods disposition in fast reactor cores on the nuclear fuel breeding and the fuel cladding temperatures is analyzed. It is shown that, if the inner breeding ratio is smaller than unity, it is expedient to locate the rods in the outlying district of the core. The results of calculations for a 1000 MW(e) reactor are given. (auth)

60046 USE OF FISSION CHAMBERS IN WATER-COOLED REACTORS. Lomakin, S. S.; Malyshev, E. K.; Belozerov, V. G.; (and others). At. Energ. (USSR); 31: No. 1, 56-7(Jul 1971). (In Russian).

A small-scale (123 mm long) fission chamber for ^{235}U neutron fluxes has been designed for reliable operation at 300°C, and details of construction are given. Gold and cobalt foils were irradiated and used to test the sensitivity and linearity of the chamber; the sensitivity during initial operation was 0.8×10^{-16} a/n/cm^2 · sec. (K.S.W.)

60047 HYDRAULIC CONTROL RODS. IDEAS AND INVESTIGATIONS FOR THE DEVELOPMENT OF FULLY HYDRAULICALLY OPERATED AND CONTROLLED CONTROL AND SHUTDOWN SYSTEMS FOR WATER AND STEAM COOLED NUCLEAR REACTORS. Muehlhaeuser, O. (Kernforschungszentrum, Karlsruhe, Ger.). Konstr. Masch., App. Geraetebau; 22: No. 6, 211-17(1970). (In German).

A control rod drive system is presented where the displacement of the control rod and the recording of the displacement path take place hydraulically. The total installation from the electrical pulse input to the control rod is given. (INIS)

60048 COMPLEX AUTOMATION OF NUCLEAR POWER PLANTS. Missbach, M.; Rehfeld, G.; Kromer, H.; Sukrow, S.; Ebersbach, H. G. (VEB Kombinat Kraftwerksanlagenbau, Berlin). Kernenergie; 14: No. 5, 137-41(May 1971). (In German).

A review of development in the field of nuclear power plant automation since end of 1968 is given. The following fields are dealt with: process control and signaling, safety systems, control techniques, nuclear measuring techniques, and process computers. 68 references. (auth)

60049 PHENIX REACTOR. MONITORING CONTROL SYSTEMS, INSTRUMENTATION, AND ELECTRICAL POWER SUPPLY. Chapelot, A. (CEN de Saclay, Gif-sur-Yvette, France). Energ. Nucl. (Paris); 13: No. 3, 206-12(May 1971). (In French).

The operation principles of the power station are related to the organization of the monitoring system adopted. Different aspects involved in the monitoring are considered: nuclear monitoring, thermal control, and the failed fuel detection system. Central data processing and the sodium instrumentation are discussed. (France)

60050 INCORE DETECTOR FOR MEASURING POWER AND BREEEDING DISTRIBUTIONS IN POWER BREEDERS. Goldstein, N. P.; Sun, K. H.; Gonzalez, J. L. (Westinghouse Research Labs., Pittsburgh). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 380-7(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

For optimum operation of fast breeder reactors, knowledge of the incore power and breeding distributions is desirable. Because of the high temperature liquid sodium environment in the breeders, an activation method rather than a technique involving ion chambers seems to be the most appropriate experimental technique at present. An activation system has been worked out in which $^1/_{16}$″ BeO balls containing oxides of ^{235}U and ^{238}U are inserted into the reactor for activation and withdrawn to be counted in a Ge(Li) counter. Measurements of the activated fission and ^{239}Np gamma-rays yield the desired information. Parameters and procedures are obtained based on a specific fast Demonstration Breeder design. However, only slight modification would be required for the application to other breeders. 3 references. (auth)

60051 STABILITY OF REACTOR CONTROL SYSTEMS IN COUPLED CORE REACTORS. Raju, G. V. S.; Josselson, R. (Ohio Univ., Athens). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 388-94(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

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For combating not only general deviations in total power, but localized flux (power) perturbations as well, separate control systems are designed for separate cores of the coupled-core reactor. Conditions are obtained for global asymptotic stability of a coupled core reactor including its control system. The results obtained for stability are in the form of the weaker Popov condition, which allows the determination of stability geometrically in the frequency domain. An example of a coupled core reactor with typical parameters is given to illustrate the ease involved in the determination of stability. 17 references. (auth)

60052 SENSITIVITY ANALYSIS OF A TWO-OUT-OF-FOUR COINCIDENCE LOGIC REACTOR PROTECTIVE SYSTEM. Tashjian, B. M. (Combustion Engineering, Inc., Windsor, Conn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 455-64(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The mathematical models for a reactor protective system were developed for sensitivity analysis. The models are for the two-out-of-four coincidence logic configuration and reflect the "spurious trip" and "no trip" system failure modes. The models, developed from conditional probabilities and series chain configuration techniques, are adaptable to other coincidence logic schemes as well. An example is included to demonstrate the sensitivity analysis technique. 2 references. (auth)

60053 SETTING TEST INTERVALS AND ALLOWABLE BYPASS TIMES AS A FUNCTION OF PROTECTION SYSTEM GOALS. Hirsch, Herbert M. (General Electric Co., San Jose, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 488-94(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The usefulness of availability design goals for determining required periodic test intervals and allowable bypass times as permitted by IEEE-279 criteria is described. Formulas are developed for calculating these times for instrumentation logic configurations common to reactor protection systems. Both simultaneous and uniformly staggered test schedules are considered. In addition to sample problems illustrating the application of these formulas, nomographs are presented for rapid graphical determination of test intervals and bypass times. 2 references. (auth)

60054 NUCLEAR REACTOR CONTROL SYSTEM. Murrell, Michael David; Davis, Dennis (to British Nuclear Design and Construction Ltd.). British Patent 1,244,965. 2 Sep 1971. Filed 29 Dec 1967.

An object of the system described is to provide a method of automatic control so that a reactor can operate with a desired neutron flux at nominally steady states, but which can also be used for startup. A signal proportional to the actual neutron flux inverse doubling time is produced and a signal proportional to a demanded neutron flux inverse doubling time is generated; these two signals are compared and their difference used to control the setting of the reactor control rods during periods of large errors in the neutron flux. The system may also be used to improve stability during periods of steady state operation. For large errors in neutron flux the system controls to an inverse doubling time subject to a limiter, while for small errors the flux is controlled to its demanded value. Either analogue or digital circuitry may be employed for obtaining the error signals from the reactor signals and for generating the appropriate automatic control law for the control rods. The flux doubling time may be measured directly or obtained by differentiating the signal representing the actual flux. (UK)

Shielding

Refer also to abstract 57779.

60055 (ORNL-TM-3573) FAST REACTOR SHIELDING MONTHLY PROGRESS REPORT FOR AUGUST 1971, 189A NO. 10028, ACTIVITY NO. 40 01 61. Mynatt, F. R.; Clifford, C. E.; Gritzner, M. L.; Maerker, R. E.; McGregor, B. J. (Oak Ridge National Lab., Tenn.). 17 Sep 1971. Contract W-7405-eng-26. 34p. Dep. NTIS.

FAST TEST REACTOR—shielding for, discrete ordinates analysis of core support grid-plate, (E/T)
—core vessel for, effects of stored fuel on neutron flux in, (T)
—shielding for, effects of composition on neutron transmission of thermal, (T)
—neutron flux monitor guide tubes for, shielding of low-level, (T)
LIQUID METAL FAST BREEDER REACTOR—coolant for, benchmark measurements on shielding effects of sodium
SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP)—shielding for reactor, discrete ordinates analysis of bottom grid-plate, (E/T) (H.D.R.)

60056 GRAPHIC DETERMINATION OF THE PARAMETERS OF THE TEMPERATURE FIELD IN THE CONCRETE OF THE REACTOR BIOLOGICAL SHIELD. Gavrilovic, Milan. Nukl. Energ.; 5: No. 6, 12-14(1968-1969).

A practical engineering graphic procedure is presented for determining the parameters of the radial temperature field in the concrete of the biological reactor shield, cooled in two vertical concentric cylindrical surfaces (the first one is the inner surface of the concrete, the second one is inside the concrete itself). The procedure has been designed for the analysis of the power reactor shields and, because of their large sizes, it has been treated in plain geometry. The exact distribution of nuclear heating, in the radial direction, has been approximated by the simple exponential function. (auth)

Cooling Systems

Refer also to abstracts 57662, 57877, 58174, 58218, and 58396.

60057 (AECL-3994) TOFA: A CDC 6600 COMPUTER CODE FOR TORSIONAL FREQUENCY ANALYSIS. Wong, P. Y. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug 1971. 34p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

TOFA is designed for studying torsional vibrations of a mechanical system. It is intended as a tool for design engineers to determine if a mechanical system is torsionally stable. An analysis of a rotor system, commonly used in coolant pumps of a commercial nuclear power reactor, is presented as an application. (auth)

60058 (ANL-7817) SODIUM TECHNOLOGY QUARTERLY REPORT, JANUARY-MARCH 1971. Kesser, G. M. (comp. and ed.) (Argonne National Lab., Ill.). Jul 1971. Contract W-31-109-eng-38. 72p. Dep. NTIS.

The research, development, and management efforts in the Sodium Technology Program for the period January–March 1971 comprised activities in the following areas: (1) In the national meter program, coordination of the national effort to produce a standardized on-line oxygen meter continued; other work included development of on-line meters for carbon and hydrogen, development of a steam-generator leak detector, and design and testing of meter modules for FFTF. (2) In the analytical standards program, work was begun on the preparation of RDT standards relating to purity specifications for sodium and cover gas; laboratory studies involved development and testing of interim methods of sampling and analysis. (3) Investigation of methods for detection and characterization of fuel-cladding failures proceeded with the development of a method for detecting ^{135}I in reactor sodium by separation and counting of its daughter ^{135m}Xe. (4) Studies of the chemistry of liquid sodium were directed toward investigation of the Na-Na$_2$O-NaOH-NaH phase diagram and examination of the vacuum distillation method as a means of determining oxygen and carbon in sodium. (5) Studies were continued on the transport of carbon in sodium-steel systems and on the development of methods for determining activities of oxygen and carbon in sodium by equilibration of metal specimens. (auth)

60059 (CONF-710606-14) CORE HEAT TRANSFER AND FLUID FLOW IN THE GCFR. Markoczy, G. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). [1970]. 28p. Dep. NTIS (U. S. Sales Only).

From seventeenth annual meeting of the American Nuclear Society; Boston, Mass. (13 Jun 1971).

Investigations of the thermohydraulic behavior of gas cooled fast reactor fuel elements are briefly reviewed. Experimental and analytical studies for the development of computer codes to predict gas, cladding, and fuel temperature distributions in fuel rod clusters are summarized. (H.D.R.)

60060 (EURFNR-904) INHERENT PROPERTIES OF THE VARIOUS PRIMARY CIRCUIT DESIGNS FOR SODIUM-COOLED REACTORS. Mueller, R. A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Translation of report KFK-1379. 32p. Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The fundamental structure of the primary circuit of sodium-cooled reactors is described. On the basis of a general descrip-

XUM

tion found by abstraction additional parameters are introduced stepwise so that the variants under consideration approach the real engineered designs. The method yields a consistent scheme comprising all possible variants up to a defined degree of refinement. The inherent properties are clearly attributed to the individual variants. All designs investigated and realized so far can be placed on specific positions in this "family tree" and thus can be definitely recognized as the specific solutions of the general system. 41 references. (auth)

60061 (GEAP-10207-24) REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY. Progress Report No. 24, January–June 1971. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jul 1971. Contract AT(04-3)-189. 47p. Dep. NTIS.

INCONEL 600—crack initiation and growth in, effects of low-cycle fatigue on, (E)
PIPES—failure in reactor cooling systems, probability analysis of
—crack initiation and growth in reactor cooling systems, effects of low-cycle fatigue on, (E)
REACTORS, BOILING—cooling system for, effects of corrosion on low-cycle fatigue life of piping in, (E)
REACTORS, WATER-COOLED—cooling systems for, failure mechanisms in piping of, (E/T)
STAINLESS STEEL—crack initiation and growth in Type 304, effects of low-cycle fatigue on, (E)
STEEL—crack initiation and growth in Type A516 carbon, effects of low-cycle fatigue on, (E) (D.L.C.)

60062 (ORNL-TM-3516) ORRIBLE: A COMPUTER PROGRAM FOR FLOW AND TEMPERATURE DISTRIBUTION IN LMFBR FUEL ROD BUNDLES. Wantland, J. L. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 28p. Dep. NTIS.

A computer program named ØRRIBLE was written to predict the flow and temperature distribution for steady single-phase flow through a bundle of nineteen heated rods spaced by helical wire wraps in a hexagonal duct. Any combination of flow subchannels can be blocked at the inlet. The section can have an unheated entrance length followed by a heated section and an unheated exit length. In the heated section the linear heat rate of each of the rods can be individually specified. Turbulent interaction, sweeping crossflow due to the wire wrap, and transverse thermal conduction are considered. An approximate relationship for pressure diversion crossflow in terms of local axial mass velocities is used to eliminate pressure as a variable. Hence the computational procedure does not require iterative techniques. ØRRIBLE can be extended to larger bundles with different internal configurations. (auth)

60063 PRESTRESSING OF PRESSURE VESSELS OF NUCLEAR POWER PLANTS WITH WRAPPED REINFORCEMENT. Hobst, L. Inzenyrske Stavby; 19: No. 2, 79-80(Feb 1971). (In Czech).

The advantages are discussed of wrapping concrete pressure vessels of nuclear power stations with a wrapped reinforcement, as compared with cable prestressing. The measurements showed that the losses induced by unequal application of the prestressing force are in the wrapped reinforcement by about 8 to 15% lower than those in curved cables. The use of a steel rope seems to be more suitable than the use of a wire 7 mm in diameter. The winding sets and the reinforcement protection against corrosion are also dealt with, and the advantages are analyzed of a vessel wall composed of several coaxial layers. (INIS)

60064 PURIFICATION OF THE COOLANT WATER BY DISTILLATION. Bagretsov, V. F.; Zakharov, S. I. At. Energ. (USSR); 30: No. 4, 347-50(Apr 1971). (In Russian).

The purification of water from the primary circuits and holding ponds by distillation was studied, examining the influence of various factors such as the productivity of the distilling apparatus, the amount of reflux, the salt concentration of the solution, and the pressure of the secondary vapor, on the amount of the produced distillate. The results indicated that the volume of the vapor space of the separator should not be reduced. Increase of the reflux over 5% affected only slightly the level of purification of the vapor from radioactive elements. Fine particles were removed by means of fiberglass, the use of which helps to eliminate scrubbers. The efficiency of the operation is characterized by the purification coefficient K_{pur} of the vapor with respect to the radioactive elements; another indicator, K_i^{app}, the isotopic particient coefficient has been proposed to calculate the concentration of radioactive elements in the vapor phase. However, values diverging by a factor of 100 were encountered in the value of K_i^{app} for ^{58}Co, ^{60}Co, and ^{59}Fe. It was found that K_{pur} depends on the salt content in the solution, which means the more deposits formed, the higher the value of K_{pur}. Thus, experimental data are needed to optimize the distillation operations. (TTT)

60065 HYDRODYNAMIC PROBLEMS OF VESSEL-TYPE BOILING-WATER REACTORS. Sarygin, A. P.; Sokolov, I. N.; Kondrat'ev, V. I.; (and others). At. Energ. (USSR); 30: No. 4, 350-3(Apr 1971). (In Russian).

Examination of the circulation in the VK-50 reactor yielded information which helped to increase the reliability of the reactor operation and the design of high-power reactors. The experiments involved measurements of temperature, pressure, and flow rate of the coolant at 35 and 70 bar at power levels ranging from the startup level to the nominal power. The flow rate of the coolant in the EBWR and Humboldt Bay reactors was twice as high as in the VK-50 reactor. Calculation of the pressure drop in the core yielded low results; it is recommended to use a correction factor for calculating flow rates under conditions of natural convection. It was concluded that natural convection represents a simple and compact heat transfer mechanism for vessel-type reactors because it operates reliably under steady-state, transient and emergency conditions. At reduced (60 to 70%) power levels a supplementary reactivity reserve is released by the decrease of the mean vapor content in the core. The results also indicated a high, 35 to 45%, vapor content and low circulation flow rate of about 0.5 m/sec. (TTT)

60066 SOLID-STATE ROD CONTROL SYSTEM FOR PRESSURIZED WATER REACTORS. Thompson, F. T. (Westinghouse Electric Corp., Pittsburgh). Westinghouse Eng.; 31: No. 2, 51-9(Mar 1971).

A flexible, highly reliable solid-state control rod drive system for pressurized water reactors is described. The modular components of the system are diagrammed, and the system operation is discussed. The operation of the system in the Robert E. Ginna power reactor is described. (H.D.R.)

60067 COOLANT RECIRCULATION SYSTEM. Townsend, Harold Edward (to General Electric Co.). British Patent 1,240,563. 28 Jul 1971. Priority date 13 Feb 1968, United States.

REACTORS, BOILING—cooling systems for, use of constant speed pumps and feedwater driven pumps in
REACTORS, WATER COOLED—cooling systems for, use of constant speed pumps and feedwater driven pumps in (H.D.R.)

60068 CAUSE AND REDUCTION OF CONTAMINATION OF THE PRIMARY COOLANT LOOP IN NUCLEAR POWER PLANTS WITH PRESSURIZED-WATER REACTORS. Bergemann, W. (VEB Kombinat Kraftwerksanlagenbau, Berlin). Kernenergie; 14: No. 5, 157-8(May 1971). (In German).

Starting from the experience gained in the Rheinsberg nuclear power plant, the causes of contamination and possibilities of its reduction are discussed. The role of chemical decontamination, salting-out, reduction of corrosion and cobalt content in the material is estimated. (auth)

60069 PRE-STRESSED CONCRETE PRESSURE VESSEL. Johnsson, Erik Borje; Tarandi, Taivo; Luthman, Per Kurt (to Aktiebolaget Atomenergi). British Patent 1,242,438. 11 Aug 1971. Priority date 7 Nov 1968, Sweden.

PRESSURE VESSELS—design of reactor prestressed concrete, with uniform distribution of stresses from lid to wall
REACTORS, WATER COOLED—pressure vessels for, means for uniform stress distribution in prestressed concrete (H.D.R.)

60070 CYLINDRICAL PRESSURE VESSEL. Andersson, Sigfrid British Patent 1,240,762. 28 Jul 1971. Priority date 17 May 1968, Sweden.

PRESSURE VESSELS—design of reactor, with thin steel shells surrounded by bolted stacks of metal rings
REACTORS—pressure vessels for, with thin steel shells surrounded by metal girders and rings (H.D.R.)

60071 PRESSURE TANK FOR A NUCLEAR REACTOR. (to Institutt for Atomenergi). British Patent 1,243,482. 18 Aug 1971. Priority date 27 Feb 1969, Norway.

PRESSURE VESSELS—design characteristics of rock shaft mounted prestressed concrete, for power reactors
REACTORS, POWER—pressure vessel for, design characteristics of rock shaft mounted prestressed concrete (D.C.C.)

60072 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Pettinger, Donald Stanley; Roberts, Geoffrey Al-

fred (to Nuclear Power Group Ltd.). British Patent 1,241,357. 4 Aug 1971. Filed 3 Oct 1969.

During the life of nuclear fuel it is desirable to progressively reduce the coolant flow through the fuel channel, so as to maintain constant temperatures at the coolant outlets, and for this purpose valves or gags are fitted to the fuel channels. Such gags are usually driven by motorized units located in members supported within the fuel channels. The drive unit and gags are removable from the reactor for maintenance purposes. With increased reactor operating temperatures difficulties can be encountered with the working parts of conventional valves and drives. In the system described the valve body has a number of openings for the passage of coolant with ball-shaped members for closing the openings to seal off coolant flow. These members are held in position by the coolant pressure and are releasable to fall under gravity into the openings. The ball-shaped members may be stored in a hopper located above the channels, and the hopper may have a metering valve controlling the release of the ball-shaped members; the hopper may be connected to the valve body by a duct the lower end of which is a spiral form in order to reduce the speed of the ball-shaped members before they enter the valve body. (UK)

60073 FLUID-COOLED NUCLEAR REACTOR. Cook, Reginald Kenneth; Burylo, Piotr Stanislaw (to British Nuclear Design and Construction Ltd. and English Electric Co. Ltd.). British Patent 1,241,269. 4 Aug 1971. Filed 23 Dec 1969.

Where a reactor has direct cycle gas turbines associated with it a problem arises in accommodating short term turbine load variations, since the thermal inertia of the reactor core is much greater than that of the turbines. Furthermore, where a turbine is located in a "pod" within the wall of a reactor pressure vessel, it is difficult to make suitable provision for controlling the flow of coolant fluid around the turbine or associated heat exchange equipment because of their inaccessibility and because such provision could interfere with the pressure vessel stressing system. In the system described means are provided to allow a proportion of cool coolant fluid fed to the upstream side of the core to by-pass the core and mix with the hot coolant from downstream of the core. The by-pass means preferably includes a variable valve. Also, a peripheral seal is provided, extending between the core and the pressure vessel walls, with at least one variable valve located in this seal. A standpipe may be provided extending through the pressure vessel above the valve with valve control means extending from the pressure vessel through the standpipe. (UK)

60074 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Nichols, Ronald William (to Atomic Power Constructions Ltd.). British Patent 1,242,533. 11 Aug 1971. Filed 15 Aug 1967.

It is stated that with higher gas temperatures and higher rates of heat transfer in modern reactors there has not been a proportionate increase in heat sink capacities. Therefore, thermal transients arising for example from power excursions have become progressively a greater problem. Such transients require expensive and sophisticated steam circuit components between heat exchanger outlets and turbines. In the system described, in addition to the main heat exchangers for removing heat from the core coolant during normal functioning, independent secondary exchangers are provided for removing heat from the coolant during operating conditions that would otherwise give rise to undesirable thermal transients and/or unstable operation in a secondary fluid system associated with the main exchangers. Advantages of the system relating to factors such as deposition on heat exchanger surfaces and blanking-off of defective tubes, and to fault conditions are described. Provision of an independent shutdown heat exchanger also facilitates core cooling in the event of a primary gas circulator failure. Other advantages of the system are also described. (UK)

60075 FRACTURE INVESTIGATIONS AND STATUS OF THE HEAVY-SECTION STEEL TECHNOLOGY PROGRAM. Witt, F. J.; Whitman, G. D. Nucl. Safety; 12: No. 5, 523-9(Sep-Oct 1971).

The Heavy-Section Steel Technology Program is one of the major nuclear pressure-vessel safety-research efforts sponsored by the U. S. Atomic Energy Commission. The scope of this investigation covers metallurgy, chemistry, material properties, inspection, analytical and experimental stress and strain analyses, environmental effects, fracture mechanics, and the general area of fracture behavior. Considerations of how thickness affects the fracture behavior of steels are studied as manifested in dynamic-tear-test specimens, nil-ductility-transition drop-weight specimens, compact-tension specimens, and flawed tensile specimens. Test results have demonstrated a significant increase in toughness levels as a function of temperature. Similar behavior is indicated to occur after the steel is subjected to high fast-neutron fluences, although there is a significant increase in the temperature at which the major portion of the change occurs. In addition, a proposed method of relating flaw size and nominal stress (load) as a function of temperature for frangible, transitional, and tough behaviors has been shown to have a potential for calculating quantitative safety margins in reactor pressure vessels. 31 references. (auth)

60076 SOME ASPECTS ON HEAT TRANSFER AND FLUID DYNAMICS OF HIGH TEMPERATURE GAS COOLED REACTOR. Okamoto, Yoshizo; Akino, Norio (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 13: No. 8, 456-61(Aug 1971). (In Japanese).

In order to extend the application of nuclear reactors, high temperature gas cooled reactors (HTGR) are being developed for their promising characteristics for multi-purpose utilization in industry. In general, multi-purpose HTGRs have an ability to generate high temperature heat steadily. The generated heat cannot only be converted to electricity, but also used for process and reduction gas preheating in iron works and chemical industries. Technical problems of heat-transfer and fluid dynamics of HTGRs up to the range of 1,000°C are classified and tabulated. Research and development items concerning reactor cores, fuels, heat exchangers and other components are described in detail. 11 references. (auth)

60077 PHENIX REACTOR. CIRCUITS AND MAIN COMPONENTS. Befre, J. L. (CEN de Saclay, Gif-sur-Yvette, France); Robin, M. G.; Delisle, J. P. Energ. Nucl. (Paris); 13: No. 3, 183-93(May 1971). (In French).

The evolution in time of the design and fabrication of the chief components of the Phenix loops is recalled. The problems which arose in the feasibility studies and the preliminary tests for each of the main components are examined (pumps, intermediate exchangers, and vapor generators). These components are described and the problems encountered in their fabrication and development are examined. (France)

60078 DFR PRIMARY CIRCUIT FAILURE. Kirk, J.; Walker, J. B. (United Kingdom Atomic Energy Authority, Dounreay, Scotland). pp 1-5 of Active Working on Reactors. London; British Nuclear Energy Society (1971).

From Meeting on active working on reactors; London, England (1 Oct 1970). See CONF-701054.

The DFR primary circuit leak was first discovered on 9 May 1967 and the reactor was finally shut down on 29 July to enable the fault to be located and repaired. Location was anticipated to be difficult because the leak was contained within the leak jacket surrounding the complicated circuit. By a variety of methods including tracer techniques using gaseous fission products and helium, the position of the leak in the extremely complicated circuit was located approximately. Final location involved the use of acoustic techniques and was accomplished by the end of November. The primary circuit vault was first entered on 12 November and finally re-sealed on 24 April 1968 after 148 pipe cutting and re-welding operations had been successfully completed. (auth) (UK)

60079 REMOVAL AND REPLACEMENT OF BOILING CHANNELS ON THE PROTOTYPE SGHWR. Green, E.; Clifton, J. J. (Atomic Energy Establishment, Winfrith, Eng.). pp 7-22 of Active Working on Reactors. London; British Nuclear Energy Society (1971).

From Meeting on active working on reactors; London, England (1 Oct 1970). See CONF-701054.

Some of the engineering operations, procedures and radiological protective measures adopted in removing six Zr—Nb pressure tubes and replacing these with Zircaloy 2 units are described. The work was carried out during a planned shut-down. In the SGHWR it is possible to obtain easy access to the core channel units. (UK)

60080 SPATIAL TEMPERATURE FIELD OF A CONCRETE VESSEL. Zdravkovic, M.; Vlajic, Milorad. Nukl. Energ.; 5: No. 6, 26-9(1968-1969). (In Serbo-Croatian).

An analytical model for the determination of the spatial temperature field caused by the working temperature and nuclear heating inside the reactor vessel has been constructed. The analytical model has been applied to the concept of a one-wall cold reactor vessel of prestressed concrete (500 MW BHWR). (auth)

60081 BEHAVIOR OF CONCRETE REACTOR VESSELS AT RAISED TEMPERATURES AND SOLUTION OF THE THERMAL PROTECTION. Stankovic, Caslav. Nukl. Energ.; 5: No. 6, 16-19(1968-1969). (In Serbo-Croatian).

An analysis has been made of the characteristics of temperature stresses in concrete reactor vessels, and the results shown

XUM

of an investigation into the behavior of concrete vessels at raised temperatures: the mechanical and thermodynamical characteristics of the concrete, and the mechanical characteristics of steel for prestressing. The conclusions hint to a further possible development of these vessels. A brief review of a solution for the thermal protection of the concrete reactor vessel for a 500 MW BHWR is presented. The problems of the deep cooling of the vessel are described. (auth)

Fuels

Refer also to abstract 58205.

60082 (ANL-7782) EXPERIMENTAL IRRADIATIONS OF FUEL ELEMENTS HAVING KNOWN CLADDING DEFECTS IN EBR-II. Brunson, G. S.; Fryer, R. M.; Strain, R. V. (Argonne National Lab., Ill.). Jul 1971. Contract W-31-109-eng-38. 45p. Dep. NTIS.

The EBR-II program to develop techniques for detecting and identifying leaking fuel elements has included experimental irradiation of fuel elements having known leaks. Two such tests are reported: a "top leaker" having a small leak in the upper weld (which, however, did not leak enough to be detected) and a bottom leaker having a small laser-drilled hole (~3-mil diameter) at the bottom end of the fuel element. After a reactor shutdown, if the primary pumps are turned off, the reduction in external pressure permits the expulsion of bond sodium containing radioactive iodine from the fuel element. The daughter xenons (especially ^{135}Xe) growing out of the expelled iodine appear as a surge in primary-tank cover-gas activity, reaching a peak 11 or more hours after the reactor shutdown. This is a useful trademark of this type of leak; a semiquantitative model is presented to explain this behavior. 12 references. (auth)

60083 (ANL-7785) FEASIBILITY STUDY OF THE IDENTIFICATION OF FUEL-CLADDING FAILURES USING SODIUM-SOLUBLE ISOTOPIC TAGS. Meyer, R. J.; Johnson, C. E.; Ross, L. E. (Argonne National Lab., Ill.). Aug 1971. Contract W-31-109-eng-38. 17p. Dep. NTIS.

Two isotopic tagging methods for locating cladding defects in sodium-bonded fuels are discussed. Both methods rely on reactor activation of the tag while it is confined inside the fuel pin. One method uses ^{121}Sb and ^{197}Au, whose activation products are ^{122}Sb and ^{198}Au. The other uses ^{198}Pt and ^{197}Au, whose activation products are ^{198}Au and ^{199}Au. Varying the weight ratios of the stable isotopes produces distinctive disintegration ratios of the activation products. Each fuel element in a particular subassembly is tagged with the same distinctive isotopic mixture. Should a cladding of a fuel element fail, the tag is released into the primary sodium coolant. Identification of a released tag identifies the subassembly in which the failure occurred. (auth)

60084 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Heaton, John Fildes; Roberts, Geoffrey Alfred (to Nuclear Power Group Ltd.). British Patent 1,204,758. 9 Sep 1970. Filed 29 Nov 1968.

A fuel element construction for a nuclear reactor comprises a block of solid neutron moderating material adapted for assembly with similar blocks to form a reactor core structure. Said block contains a plurality of substantially parallel passages each containing a nuclear fuel-containing member having cross-sectional dimensions such that when the member is located in a passage a clearance is left between the member and the wall of the passage for the flow of cooling fluid. Each said member has a plurality of spaced axially extending lugs on its surface adapted to contact the wall of the passage. (IIB)

60085 PHENIX REACTOR. THE FUEL ELEMENTS. Ratier, J. L. (CEN de Cadarache, Saint-Paul-les-Durance, France). Energ. Nucl. (Paris); 13: No. 3, 194-5(May 1971). (In French).

The fissile element and the fertile element are briefly described. The principal characteristics of the fuel assembly are given. (France)

Auxiliary and Emergency Systems

Refer also to abstracts 57783 and 60208.

60086 REACTOR CONTAINMENT-BUILDING SPRAY SYSTEMS FOR FISSION-PRODUCT REMOVAL. Row, Thomas H. Nucl. Safety; 12: No. 5, 516-22(Sep-Oct 1971).

Containment-building spray systems as fission-product-removal devices are becoming widespread in pressurized-water-reactor design, and the AEC has been sponsoring a research program to investigate the applicability of these systems as engineered safety features. Three spray solutions are presently in use or being seriously considered by plant designers. Molecular iodine removal by these sprays is very effective, and decontamination factors ranging from 20 and 1000 may be obtained, depending on the solution selected. The explosion hazard from generation of radiolytic hydrogen, first identified in this program in 1967, continues to require serious consideration in plant design. 23 references. (auth)

60087 PHENIX REACTOR. FUEL AND SPECIAL HANDLING FACILITIES IN THE REACTOR. Benoist, E. (CEN de Cadarache, Saint-Paul-les-Durace, France); Boulinier, C. Energ. Nucl. (Paris); 13: No. 3, 196-205(May 1971). (In French).

The handling operations are usually performed during reactor shutdown periods, and do not last long because of the small number of components involved. The handling of elements relating to control rods, guide tubes, fuel, fertile and shielding assemblies, includes: the preparation of new elements, transfer to the reactor, loading and unloading of the reactor, outside drum storage; conditioning and dismantling of spent elements in the hot cell; evacuation to the reprocessing plant or to the solid waste storage area. The systems for handling the primary pumps and exchanger, the control rods and mechanisms, the transfer arm, and other irradiation devices, include: special flasks; storage and wash down pits; the dismantling cell. Preliminary and full scale prototype tests on fuel handling devices demonstrated the viability of the solution adopted. (France)

60088 CHARACTERISTICS AND DESIGN BASES OF CHARCOAL FILTER. Aoki, Toshio (Kansai Electric Power Co., Japan). Nippon Genshiryoku Gakkaishi; 13: No. 8, 462-7(Aug 1971). (In Japanese).

The important quantities of halogen vapor that might be released normally and abnormally into the reactor building and/or into the vent systems of the reactor plant are usually removed by charcoal filters installed in the vent ducts and recirculation air ducts in the containment of a reactor. The mass transfer theory is applied analytically to the adsorption mechanism of charcoal beds incorporating the isotopic exchange of methyl iodide in an impregnated charcoal filter, to explain the two cases of constant inlet mass concentration (vent system) and constant initial concentration (recirculation system). Filter efficiencies are discussed on the above two cases, as well as leakage problems including an extreme case of high temperatures combined with almost 100% humidity, and remarks are offered on leakage tests by freon gas to get the bases for design and maintenance of systems. (auth)

60089 DETECTION OF BOILING IN NUCLEAR REACTORS. Saxe, R. F. (North Carolina State Univ., Raleigh). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 337-9 (Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The subject of the detection of boiling in nuclear reactors has become important with the impending construction and operation of Liquid-Metal, Fast-Breeder Reactors for power production. Several methods for the possible detection of boiling by equipment located outside the reactor have been proposed and investigated and have, in general, been reduced to two methods. Experiments were performed to assess the relative sensitivities of these two methods. It is shown that a large difference in sensitivity exists between the two methods. 9 references. (auth)

60090 HIGH-TEMPERATURE ACOUSTIC SENSORS FOR BOILING DETECTION. Gavin, A. P.; Anderson, T. T. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 340-4(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A system utilizing immersed acoustic noise detectors to detect boiling is one possible solution to the problem of detecting loss of cooling in a fuel channel of a liquid metal cooled fast breeder reactor. Two models of a symmetric drive sensor incorporating lithium niobate as the piezoelectric element have been fabricated and tested for acoustic response in water at room temperature and in an air furnace up to 600°C. Sensitivities of both models were 500 pC/bar, with acoustic response to 100kHz when immersed in water. The sensors were not adversely affected by exposure in the furnace. Decreasing internal resistance with increasing temperature limits the useful range of present models to about 540°C. 12 references. (auth)

60091 EARTHQUAKE-RESISTANT NUCLEAR REACTOR STATION. Busey, Harold M. (to McDonnell Douglas Corp.). U. S. Patent 3,599,589. 17 Aug 1971. Filed 29 Dec 1967.

A floating structure is described for the protection of nuclear reactors from damage during earthquake shock. The structure is designed to absorb shocks without rupture of critical nuclear reactor equipment. (auth)

Operation and Economics

60092 (AECL-3910) PLUTONIUM RECYCLE IN CANDU-TYPE PHW HEAVY WATER REACTORS. Duret, M. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). May 1971. 14p. Dep. NTIS (U. S. Sales Only). AECL $0.50.

Fuel cycle costs for DANDU-PHW reactors of the Pickering type using natural UO_2 homogeneously enriched with plutonium are compared with costs obtained using only natural uranium. Four consecutive plutonium recycles are considered, which is enough to indicate the effect of the growing ^{242}Pu concentration on burnup and hence, costs. The effect of plutonium salt is considered. The reactor system envisaged corresponds to that of the Ontario Hydro Electric Power Commission, which is expected to increase to about 19,000 MW(e) in 1990. Total system fuel cycle costs are examined over this period. (auth)

60093 (AECL-3995) PLUTONIUM PRODUCTION IN NPD: A COMPARISON BETWEEN EXPERIMENT AND CALCULATION. Duret, M. F.; Griffiths, J.; Bir, R.; Chabrillac, M.; Vidal, R. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug 1971. 23p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

The Canadian Nuclear Power Demonstration Reactor (NPD) is a heavy water cooled and moderated, horizontal pressure tube reactor with a power level of about 25 MW(e). Most of the fuel is in the form of short (50 cm) bundles of Zircaloy-clad, natural UO_2 fuel pins in a 19-element circular array. In 1968 a series of eight of these bundles with irradiations covering the range 1000–10,000 MWd/tU was mass spectrometrically analyzed by the CEA in France. The bundles were selected to have an irradiation history typical of an unperturbed CANDU-type reactor with bi-directional on-power fuelling. Gross gamma-ray measurements were made on each pin to check burn-up homogeneity and so that representative pins could be selected. From each bundle, six pins of twelve in the outer ring, three pins of six in the inner ring, and the central pin were dissolved and analyzed. Uranium analyses were made with a UF_6 mass spectrometer giving a very good accuracy on ^{235}U depletion measurements and a thermo-ionization device was used for plutonium analyses. The amounts of plutonium and neodymium were determined by the isotopic double dilution method. These measurements provided relative concentrations of ^{235}U, ^{236}U, ^{238}U, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu and ^{148}Nd in each ring of each bundle. Burnup values were determined from the ^{235}U/^{238}U ratios, and ratios of other isotopic abundances were compared to predictions made using both Canadian and French methods of lattice calculation. In general, the agreement is good. (auth)

60094 (CONF-710922-2) REVIEW OF FAST REACTOR OPERATING EXPERIENCE. Cohen, Karl (General Electric Co., Sunnyvale, Calif.). [1970]. 17p.

From International conference on fast reactors; Aix-en-Provence, France (2 Sep 1971).

Design characteristics for operating and planned liquid sodium cooled fast reactors are compared. Operating experiences for liquid sodium cooled reactors are discussed under the following topics: fuel; refueling; instrumentation and controls; sodium technology; auxiliary systems; major heat transfer components; and availability and maintainability. 10 references. (D.C.C.)

60095 (IAEA-R-742-F) ANALYSIS OF URANIUM BURN-UP AND PLUTONIUM BUILD-UP IN FAST REACTORS. Final Repor for the period 1 January–31 December 1960. Orlov, V. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). Aug 1970. 86p. (In Russian). Dep. NTIS (U. S. Sales Only).

Completed and projected construction of atomic electric power plants in the various countries of the world is summarized. A program is offered for the computation of the changes in isotopic composition of fuel in various types of nuclear reactors. The program is divided into spatial and time portions to yield burn-up of U and accumulation of Pu. Examples of the calculations are given for each of four fuel cycles: uranium reactor reprocessor; plutonium breeder reactor; thorium breeder reactor; and breeder reactor with mixed fuel. Repeated fuel recovery is also treated. 16 references. (K.S.W.)

60096 (ORNL-4676, pp 1-20) MOLTEN-SALT REACTOR EXPERIMENT. (Oak Ridge National Lab., Tenn.). Aug 1971.

In Molten-Salt Reactor Program semiannual progress report for period ending February 28, 1971.

MOLTEN SALT REACTOR EXPERIMENT—core for, postoperation examination of
—fuel pump bowl for, postoperation examination of
—heat exchanger for, postoperation examination of
—fuel salt freeze valve for, postoperation inspection of leak in
—maintenance of, tools and procedures for remote
—coolant salt flowmeter for, accuracy of differential pressure system on, (E)
—fuel salt processing plant for, residual plutonium and uranium in (H.D.R.)

60097 (ORNL-TM-3525) EVALUATION OF PLUTONIUM USE IN HIGH-TEMPERATURE GAS-COOLED REACTORS. Kasten, Paul R.; Bennett, Leonard L.; Thomas, W. E. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 29p. Dep. NTIS.

High-temperature gas-cooled reactors (HTGRs) are generally proposed for operation on the thorium fuel cycle using highly enriched ^{235}U as initial and makeup fissile fuel, with recycle of the bred ^{233}U. However, development of a fuel recycle technology also inherently develops the ability to fabricate plutonium-fueled HTGR fuel elements. Thus, light water reactors (LWRs) which produce plutonium, fast breeder reactors (FBRs) producing excess plutonium (or ^{233}U), and HTGRs can work together. A systems analysis study was therefore performed to help clarify the role that HTGRs might play in utilizing plutonium from light water reactors in the near future and from FBRs at times when plutonium production exceeds breeder reactor requirements. These investigations considered competition between LWRs, FBRs, HTGRs, and fossil plant types with HTGRs utilizing either ^{235}U or plutonium as the makeup fuel (the initial fissile fuel was ^{235}U for both cases). The effects of rising ore prices, separative work prices, values of bred fissile materials, and changing capital costs with time were included in the calculations. The basic tool used in these studies was a linear programming optimization model of the U. S. utility industry, which determines the optimum long-term expansion plan of the industry with minimum cost as the objective function. The results indicate that use of the plutonium-makeup fuel cycle permits HTGRs to have a much deeper penetration of the power market than use of the ^{235}U-makeup fuel cycle alone (1075 plants vs 493); plutonium-makeup HTGRs are economically preferred over plutonium-fueled LWRs over the period of this study (1970-2015); use of Pu-makeup HTGRs has no significant influence on the introduction and use of FBRs; as the price of uranium ore rises and the price of plutonium decreases, it will eventually be necessary for HTGRs to operate with plutonium as the initial fissile fuel if they are to compete with LWRs fueled with uranium tails and plutonium; and if FBRs produce excess fissile fuel it appears economically desirable that such fuel be ^{233}U for use in HTGRs. 7 references. (auth)

60098 ADVISABILITY OF OPERATING NUCLEAR POWER PLANTS AT A REDUCED POWER LEVEL BEFORE REFUELING. Mityaev, Yu. I. At. Energ. (USSR); 30: No. 4, 339-43(Apr 1971). (In Russian).

Operators of several power plants such as the Yankee Atomic reactors and the Novo-Voronezh power plant reduce the power before refueling; a considerable amount of electricity is generated during the low-level operation. Calculations were made to determine under which conditions such an operating scheme be economically profitable by reducing the net cost of the generated electricity. For the calculations it was assumed that the reactor contained identical fuel channels resulting in an improved burnout and that the power plant operates without requiring reprocessing of the fuel. The calculation involved a comparison of operation with and without reducing the power level before refueling, keeping the amount of electricity generated between reloading or the number of reloaded channels identical. The results indicated that reduction of the power before reloading helps to reduce unproductive neutron losses in the control rods. This results in the reduction of the net costs of the generated energy if the number of reloaded fuel channels is increased. It is recommended to use such an operational scheme for vessel-type, light-water reactors with a relatively high power coefficient of reactivity. (TTT)

60099 PLAN AHEAD FOR DECONTAMINATION. Bell, Robert S. Power Eng.; 75: No. 8, 38-40(Aug 1971).

Procedures and requirements for the decontamination of power reactor components are described. Component maintenance and replacement requirements for different reactor types are discussed in terms of decontamination problems. (D.C.C.)

60100 EFFECT OF CONDENSING THE SPATIAL MESH ON THE ACCURACY OF FAST BREEDER FUEL-CYCLE ANALYSES. Alcouffe, Raymond E.; Hirons, Thomas J. (Los Alamos Scientific Lab., N. Mex.). Nucl. Sci. Eng.; 45: No. 3, 333-5(Sep 1971).

Calculational results that employ the collapsing theory are presented. This theory is utilized to reduce the spatial mesh used to perform the fuel-cycle analysis of a large fast breeder. These results indicate that a satisfactory analysis can be performed while reducing a typical two-dimensional spatial mesh by a factor of 30. Only the reduction of the spatial mesh is described. (auth)

60101 OPTIMAL CONTROL ROD PROGRAMMING OF LIGHT WATER REACTORS IN EQUILIBRIUM FUEL CYCLE. Motoda, Hiroshi (Hitachi Ltd., Kawasaki, Japan). Nucl. Sci. Eng.; 46: No. 1, 88-111(Oct 1971).

A generalized treatment for investigating the effects of various refueling schemes on the optimal control rod programming that maximizes the average burnup of discharged fuels in a two-region, radially one-dimensional light water moderated nuclear reactor is presented and applied to a boiling water reactor having uranium fuel of a single ^{235}U enrichment. It is assumed that the refueling scheme has reached an equilibrium fuel cycle, and the analysis by burnup space is applied, which helps in interpreting geometrically the coupled effect of the control rod programming and the fuel burnup by the trajectory drawn in this space. Three refueling schemes are considered: parallel, series out-in, and series in-out. Scatter loading is assumed in each region and the batch number and volume fraction of each region are varied as the refueling parameters. Fuel management and poison management constitute a hierarchy relation, and the effect of the refueling schemes on burnup maximization or enrichment minimization is several times greater than that of the control rod programmings. However, the policy of the optimal control rod programming strongly depends on the refueling scheme. The power density of the inner region should be as high as possible for out-in scheme (inner high policy) and vice versa for in-out scheme (outer high policy). However, either policy can be optimal, depending on the refueling parameters for parallel schemes, and in some cases the optimal control rod programming is not unique (degenerate policy). Optimal control rod programming increases the discharge burnup or decreases the enrichment of the feed fuels by about 0 to 4% over the conventional constant power shape operation. The difference is mainly determined by the reactor design and the refueling scheme. Optimal refueling should be chosen from among parallel schemes, which have much larger freedom than series schemes. (15 references) (auth)

60102 ECONOMIC CHARACTERISTICS FOR FUEL CONSUMPTION IN NUCLEAR POWER STATIONS. Marx, D.; Steinbock, P. (Technische Univ., Dresden). Kernenergie; 14: No. 5, 142-4(May 1971). (In German).

Starting from the necessity to apply uniform systems of characteristics to all components of the process of reproduction in the generation of electric energy, characteristics of fuel consumption for nuclear power stations in accordance with standardized characteristics for conventional power plants are presented. A suggestion is made for determination, planning, and clearing of nuclear fuel consumption in such a manner that the latter becomes an integrated part of normative cost accounting. (auth)

60103 OPTIMAL STRATEGIES IN REACTOR SYSTEM ECONOMICS. Nelson, Paul Jr.; Young, Gale (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng.; 46: No. 1, 140-7(Oct 1971).

The breeding of nuclear fuel and its transfer between reactors cause the different reactor types to be interacting components of a system which may have fairly complex optimal strategies. This is illustrated in an idealized example employing two types of reactors. For simplicity it is assumed that both reactors use and produce the same kind of fuel, and that this fuel can also be purchased externally (e.g., from a uranium mining and diffusion plant operation) as needed, at constant price. A global or other large economically isolated power system required to generate a prescribed total power output P(t) over some period of time is considered. The problem is to employ the different reactors in such a way as to accomplish this in the most economical manner. (auth)

60104 APPLICATION OF LINEAR PROGRAMMING TO REFUELING OPTIMIZATION FOR LIGHT WATER MODERATED POWER REACTORS. Suzuki, Atsuyuki; Kiyose, Ryohei (Tokyo Univ.). Nucl. Sci. Eng.; 46: No. 1, 112-30(Oct 1971).

The fuel management optimization problem within a light water moderated nuclear reactor is formulated as a multistage decision process, and the amount of fresh fuel in each zone and the shuffling schemes of reloading fuel are simultaneously determined so as to minimize the consumption of fresh fuel throughout plant life. The problem in case of a five-zone core involves about 8000 variables and about 2000 constraints on the variables. However, it is shown that the optimal refueling policy can be obtained in a reasonable length of computing time by using linear programming and, prior to the overall optimization calculation, by solving the subproblem of minimizing the stagewise consumption of fresh fuel. The optimal refueling policy results in reduction of the consumption of fresh fuel by about 10% compared with the conventional policy of uniform partial batch refueling. The essential assumption in the calculation model is that the spatial power distribution in the core does not change significantly with time and the optimal allocation of energy output (integrated power output) for each zone can be attained by optimizing the control rod programming for one core life. Three-dimensional depletion calculations are repeatedly performed to verify feasibility of the model based on that assumption. 22 references. (auth)

60105 STABILITY STUDY OF A PWR NUCLEAR POWER STATION CONNECTED TO AN ELECTRIC POWER SYSTEM. Obinata, Sumiko; Kobayashi, Shigeo; Wakamatsu, Seiji (Electrotechnical Lab., Tokyo). Denshi Gijutsu Sogo Kenkyusho Iho; 35: No. 2, 129-44(Feb 1971). (In Japanese).

The overall system stability of an electric power system which includes a PWR nuclear power station under governor-free operation is described. First the whole system is divided into two independent subsystems, the power plant internal system and the electric power system, respectively. The stability of the individual subsystems and that of the total system are discussed. It has been concluded that the interaction between the two subsystems is not strong under governor-free operation, and that, therefore, the total system is stable enough if both subsystems are stable. (auth) (Japan)

60106 ACTIVE WORKING ON REACTORS. Proceedings of the Joint International Discussion Meeting, London, October 1, 1970. London; British Nuclear Energy Society (1971). 84p. £ 1.75. (CONF-701054).

Eight papers were presented. A separate abstract was prepared for each paper. (UK)

For abstracts of individual papers see: 59923–59926, 60026, 60078, 60079, and 60107.

60107 TOOLS AND RECOVERY EQUIPMENT. Compton, S. J. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). pp 47-56 of Active Working on Reactors. London; British Nuclear Energy Society (1971).

From Meeting on active working on reactors; London, England (1 Oct 1970). See CONF-701054.

High radiation restricts access to nuclear reactors for repair work which necessitates special tools and equipment to be developed for this purpose. Efficient viewing equipment is an essential requirement for the true assessment of the situation inside the reactor. Small items lost inside the reactor are usually recovered by using the television camera grab attachment or simple snares. The dismantling of equipment in-pile would probably require tools or equipment designed specifically for the job, and operated remotely, and would thus not normally be useable for any other purpose. In the event of a fuel channel melt-out incident the presence of contamination would make the recovery work much more difficult, and complicated equipment would be required due to the necessity to prevent the spread of contamination. Equipment was developed for remotely carrying out measurements and for taking samples of materials from components inside the reactor. (auth) (UK)

60108 METHODS FOR THE ANALYSIS OF THE RENTABILITY OF NUCLEAR POWER PLANTS AND THEIR APPLICATION IN YUGOSLAVIA. Mojovic, Ljubomir. Nukl. Energ.; 5: No. 6, 1-8(1968-1969). (In Serbo-Croatian).

The economic factors of interest for the assessment of the rentability of nuclear power plants are being considered. The method of the integral annual costs used in Yugoslavia for the economic analysis of power plants is applied to nuclear power plants, paying due regard to the current regulations and recommendations for such analyses. The methods and criteria for evaluating the rentability of projects and their intercomparison from the point of view of national economy are analyzed. A discussion follows on the feasibility of certain methods and criteria. The setbacks of using for this purpose the integral annual costs obtained by the usual procedure employed in Yugoslavia are described. The use of certain criteria for nuclear power plants is discussed. (auth)

60109 TRANSMISSION IN THE 1980'S. Begent, H. H. (English Electric Power Transmission Ltd., Stafford). Elec. Rev.; 189: No. 9, 301-2(Aug 1971).

The most promising means for improving the competitive position of electricity are by the use of fast breeder reactors and the improvement of load factor. Developments in ac and dc transmission systems for use with fast reactors are discussed. It is concluded that underground 300 kV systems are the most promising. They are compared with the ultra high voltage overlay of large power pools. (UK)

60110 EMERGENCY COOLING SYSTEM FOR A NUCLEAR POWER GAS TURBINE. Bammert, K. (Inst. of Turbomachinery and Gasdynamics, Hanover). Atomkernenergie: 18: No. 2, 131-2(1971).

The aftercooling of a gas cooled high-temperature reactor is described which during normal operation delivers its primary heat to a direct-cycle gas turbine. (auth)

Safety and Siting

60111 (BMI-1917) AN EVALUATION OF THE APPLICABILITY OF EXISTING DATA TO THE ANALYTICAL DESCRIPTION OF A NUCLEAR-REACTOR ACCIDENT. Quarterly Progress Report, April-June 1971. Carbiener, Wayne A.; Ritzman, Robert L. (Battelle Columbus Labs., Ohio). Sep 1971. Contract W-7405-eng-92. 80p. Dep. NTIS.

FISSION PRODUCTS—deposition in reactor containment buildings, effects of heat transfer characteristics on, (T)
—release in reactor coolant loss accidents, evaluation of source-term guidelines for estimation of
IODINE—deposition in reactor containment buildings, heat transfer model for analysis of
REACTOR CONTAINMENT STRUCTURES—fission product deposition in, effects of heat transfer characteristics on, (T)
REACTORS, BOILING—coolant loss accidents in, analytical description of
REACTORS, PRESSURIZED WATER—coolant loss accidents in, analytical description of
REACTORS, WATER COOLED—control rod dropout accidents in, transient response following, (T)
—coolant loss accidents in, ECCSA and MUCHA codes for thermal-hydraulic analyses of
—emergency core cooling systems for, linearized-implicit formulation of fluid flow model for
—coolant loss accidents in, design parameters of scale model facility for analysis of (H.D.R.)

60112 (CEA-CONF-1797) FLINA CODE. Rousseau, J. C. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires. Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). [1971]. 11p. (CONF-710630-1). Dep. NTIS (U. S. Sales Only).

From European two-phase flow group meeting; Riso, Denmark (9 Jun 1971).

The FLINA code concerns reactor safety and was written for treating problems arising from boiling sodium. The code describes the stable or transient thermodynamic flow of a two phase fluid in the channel of a reactor or test loop. The code was established using models resembling those of FLICA. The numerical methods were adapted to the special treatment of critical flow. Furthermore, in the transient case, these methods allow the treatment of acoustic problems as well as slow variations. This code was initially intended for the description of boiling sodium, but preliminary tests demonstrated that it could also be used for treating problems such as periodic expulsion in a heating channel, all types of oscillation in the heat exchangers, and depressurization in the primary circuit of a reactor plant. Some relevant examples are cited. (France)

60113 (CONF-710922-3) REVIEW OF FAST REACTOR SAFETY. Farmer, F. R. (United Kingdom Atomic Energy Authority, Risley (England). Authority Health and Safety Branch). [nd]. 14p. Dep. NTIS (U. S. Sales Only).

From International conference on fast reactors; Aix-en-Provence, France (2 Sep 1971).

A whole variety of phenomena which bear on fast reactor safety is presented. The subjects which are introduced but not discussed in depth range from sodium fires, decay heat removal, core meltdown and sub-assembly events. Particular designs or design solutions to specific problems are not discussed. (auth)

60114 (CONF-711103-1) HEAT TRANSFER FROM ELECTRICALLY HEATED RODS DURING A SIMULATED LOSS-OF-COOLANT ACCIDENT. Lawson, C. G. (Oak Ridge National Lab., Tenn.). [1971]. 38p. Dep. NTIS.

From American Institute of Chemical Engineers meeting; San Francisco, Calif. (29 Nov 1971).

Transient heat-transfer data are presented for single Zircaloy clad heaters (0.5-in.-OD × 2-ft-long) and a seven-rod cluster in a closed cycle, circulating, 1500 psi pressurized, water loop at power levels of 17.5 kW/ft (450,000 Btu/hr · ft^2) with cooling water near 500°F inlet and 1500 psi during a 12-second depressurization and coolant loss. Flow regimes associated with bulk-nucleate boiling and with thin film surface evaporation are clearly discernible where the temperature difference and heat flux data are considered. The high heat-transfer coefficients were observed for times greater than the heat-removal time constants of the heater rods and suggest that assumptions made in current calculations are conservative. (12 references) (auth)

60115 (HEDL-SA-164) TRANSLATING ELEVATED TEMPERATURE MATERIAL PROPERTIES INTO RULES FOR STRUCTURAL DESIGN. Jakub, M. T.; Moen, R. A.; (and others) (Hanford Engineering Development Lab., Richland, Wash.). [1971]. Contract AT(45-1)-2170. 51p. (CONF-710903-2). Dep. NTIS.

From first international conference on structural mechanics in reactor technology; Berlin, Germany (20 Sep 1971).

A description is given of how existing data on austenitic-type stainless steel material were utilized to establish structural design rules for the Fast Flux Test Facility (FFTF). These rules govern the design of all heat transport system pressure boundaries, including the core support and core holddown structures. In addition to limiting design against material degradation from mass transfer and irradiation damage, the rules are intended to guard against structural failure from ductile rupture, ratchetting, gross deformation, buckling instability, and creep-fatigue interaction. (auth)

60116 (HMI-B-113) CHEMICAL ASPECTS OF REACTOR SAFETY. Hoinkis, E. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Aug 1971. 52p. (In German). Dep. NTIS (U. S. Sales Only).

Papers related to chemical problems in both normal and abnormal reactor operation are reviewed. Aspects covered include: (1) release and transport of fission products; (2) release and adsorption of iodine and iodine compounds; (3) aerosol production and behavior; (4) chemical reactions of cladding material; (5) oxidation of graphite and coated particles; (6) chemical reaction of fuels; (7) chemical reactions in sodium loops; and (8) corrosion in water-cooled reactors. 155 references. (H.D.R.)

60117 (KFK-1380) PROPAGATION OF LOCAL DISTURBANCES IN THE CARE OF FAST SODIUM-COOLED REACTOR AND THEIR SIGNIFICANCE FOR REACTOR SAFETY. Gast, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). May 1971. 162p. (In German). Dep. NTIS (U. S. Sales Only).

The problem of propagation of local cooling disturbances and fuel element faults in the core of a sodium cooled fast breeder reactor is analyzed. Initial faults, their possible consequences and potential mechanisms to cause a nuclear accident are discussed and are weighed in their importance with regard to reactor safety. Among possible chains of events two critical paths are identified: local cooling disturbances within a fuel element bundle, which could, via successive failure of fuel pins or local boiling, lead to gross boiling and sodium ejection from the entire fuel element and finally to an explosive interaction between overheated fuel and sodium; and simultaneous rupture of many cladding tubes in the gas plenum region of a fuel element, resulting in a sudden release of considerable amounts of fission gas, which could lead to a nuclear excursion via the sodium-void-reactivity. The latter problem of sudden fission gas release is solved by a simple change in the fuel element design. Of the former chain of faults, the most important individual events are analyzed, especially with respect to their detectability by means of special monitoring instruments. A first analytical model is developed to describe the process of local sodium boiling in a pin bundle geometry. The model is based on the assumption of single bubble boiling at considerable superheat. The thermal hydraulic properties of a fuel element bundle are considered. In the numerical calculations, the effects of sodium superheat and of the temperature field in the disturbed region are investigated parametrically. 82 references. (auth)

60118 (ORNL-4727) DEFORMATION AND RUPTURE BEHAVIOR OF LIGHT-WATER REACTOR FUEL CLADDING. Hobson, D. O.; Rittenhouse, P. L. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 20p. Dep. NTIS.

XUM

The results of transient-temperature burst tests performed on Zircaloy cladding tubes are presented. These establish base-line criteria with reference to reactor loss-of-coolant accidents and materials parameters and provide a basis for comparisons among multirod tests, tests with irradiated cladding, and in-reactor experiments. This study delineates the maximum expansion to be expected from each combination of pressure and heating rate and shows, rigorously, the effect of wall thickness variation on expansion. In addition, the α-to-β transformation is shown to have a large effect on the strain and rupture behavior of the tubing. (auth)

60119 PROBLEM OF LOCATING NUCLEAR POWER PLANTS. **Gerisch, G. (Institut fuer Energetik, Leipzig). Kernenergie; 14: No. 5, 133-6(May 1971). (In German).**

From the general contents and the importance of the territorial structure of production processes special requirements and conditions concerning the site of nuclear power plants are derived. The relations between power plants and their environment are analyzed. Considering the qualities of nuclear fuel, the requirement on safety of environment and the economic effect of different cooling methods, the locating of nuclear power plants is regarded as a problem of optimization. For its solution a practically tested conception is presented. In conclusion, trends of the locating of nuclear power plants are deduced. 9 references. (auth)

60120 RADIATION MONITORING. **Hekkala, Barney. Power Eng.; 75: No. 9, 44-6(Sep 1971).**

Methods for surveillance of nuclear power plants for radioactivity in effluents and in plant systems are described. Engineered systems tailored to the requirements of a specific plant are discussed. (H.D.R.)

60121 ANALYSIS OF MECHANICAL WORK ENERGY FOR LMFBR MAXIMUM ACCIDENTS. **Padilla, Andrew Jr. (Hanford Engineering Development Lab., Richland, Wash.). Nucl. Technol.; 12: No. 4, 348-55(Dec 1971).**

The evolution of analytical methods for predicting the mechanical work energy for LMFBR maximum accidents are reviewed. The analytical methods based on the thermal interaction of molten fuel with sodium are discussed in detail and comparisons of mechanical work energies, pressure-time histories, and temperature-time histories are made. Areas for further work are suggested. 21 references. (auth)

60122 RELIABILITY REQUIREMENTS FOR NUCLEAR POWER PLANTS. **Knecht, O.; Zeibig, H. (INTERATOM, Bensberg, Ger.). Kerntech. Atomprax.; 13: No. 7-8, 314-18(Jul-Aug 1971). (In German and English).**

In planning a nuclear power plant it is necessary to establish how reliable the individual component systems must be in order to achieve a stipulated safety rating and a stipulated availability of the plant as a whole. The safety engineering aspect of this problem is discussed, with the derivation of reliability requirements from a stipulated permissible overall risk resulting from unforeseen events (malfunctions). Using the reactor SNR-300 as an example, it is shown that the decisive criterion for the reliability requirements for the safety facilities of a reactor is the radiological component of the overall risk. A numerical example is given for the controls of the primary cycle pumps which must be automatically slowed down and stabilized at an after-cooling speed of revolution of 5% after a reactor scram. The correlation between the design basis for nuclear power plants and the risk analysis method is also discussed. (auth)

60123 PROTECTION AGAINST REACTOR EMERGENCIES ASSOCIATED WITH REACTIVITY PERTURBATIONS. **Grebenyuk, G. G.; Dorri, M. Kh.; Solov'ev, M. M. This paper was summarized in At. Energ. (USSR); 29: No. 5, 363-4(Nov 1970) as paper No. 439/5361. (In Russian).**

A method is examined for protection against reactor emergencies associated with reactivity perturbations, based on a system of automatic power regulation. Among such emergencies are obstruction of the fuel channels in the active zone and disruption of normal cooling of the fuel elements, which results in the overheating of parts of the active zone and causes reactivity perturbations. A method is proposed for detecting emergency situations from indirect evidence — the appearance of an emergency perturbation in the reactivity. (auth)

60124 UTILITY OF ICE CUBES AS AN ABSORBENT FOR GASEOUS FISSION PRODUCTS. **Soldano, B. A. (Furman Univ., Greenville, S. C.); Ward, W. T. Nucl. Technol.; 12: No. 4, 363-6(Dec 1971).**

Ice cubes, which were made using a base-borate solution containing 1 wt % $Na_2S_2O_3$, were found to be effectively 100% efficient in removing I_2 from an I_2-air stream, but neither additive was found to be effective for trapping CH_3I if the water was in the form of ice cubes. (auth)

60125 RELIABILITY-ENGINEERING METHODS IN REACTOR-SAFETY TECHNOLOGY. **Rubel, Paul. Nucl. Safety; 12: No. 5, 496-9(Sep-Oct 1971).**

Reliability engineering seeks deliberately to increase the likelihood that devices or systems will function as intended. To this end, analytical techniques are routinely applied in fields such as aerospace in ways that give rotational direction to the various quality-assurance activities. A recent survey of similar applications to enhance reactor safety revealed that, although qualitative-analysis methods have been adopted widely, probabilistic modeling and risk forecasting have been somewhat restricted by lack of adequate supporting information. Probabilistic analysis use is expanding, however, as current efforts gradually overcome the information problem. Meanwhile, quality assurance has benefited from the insight provided by the preliminary risk-evaluation studies. 9 references. (auth)

60126 FUEL-ROD FAILURE AND ITS EFFECTS IN LIGHT-WATER-REACTOR ACCIDENTS. **Rittenhouse, P. L. Nucl. Safety; 12: No. 5, 487-95(Sep-Oct 1971).**

The status of research and testing for identifying the modes of fuel-rod failure that may result from a loss-of-coolant accident in a light-water-cooled reactor and the influence of such failures on the efficiency and effectiveness of emergency cooling are reviewed. Subjects covered include deformation and rupture of Zircaloy cladding of fuel rods, coolant-channel blockage resulting from this mode of fuel-rod failure, and embrittlement of cladding by reaction with steam. The effects of all these factors on the integrity of the reactor core and on the ability to cool the core are discussed. 22 references. (auth)

60127 COMPUTER CODES FOR ANALYZING NUCLEAR ACCIDENTS. **Winton, M. L. Nucl. Safety; 12: No. 5, 461-87(Sep-Oct 1971).**

Many computer programs have been developed for use in various aspects of nuclear accident analysis. The Nuclear Safety Information Center has separated over 200 of these codes into 15 groups and tabulated them. The resulting table gives name of code, machine on which it is operable, its language, corporate author, a statement of what the code does, a reference citation, and date of the reference. An outline of the analysis of a loss-of-coolant accident is given, and codes that might be used in the analysis are briefly discussed. Several comparisons of similar codes are cited, and some of the results are discussed. In addition, there is notation of those codes on which information may be obtained from the Argonne Code Center, the European Nuclear Energy Agency (ENEA) Library at Ispra, and the Radiation Shielding Information Center. 9 references. (auth)

60128 OUTCRY OVER EXPOSURE GUIDELINES. **Auxier, J. A. Nucl. Safety; 12: No. 5, 456-60(Sep-Oct 1971).**

There has been a growing public concern about radiation pollution of the environment over the past few years. Also, the public news media have given increased coverage to individuals critical of the radiation-exposure guides and standards recommended by the Federal Radiation Council and other national and international committees and councils. The recommendations of the Federal Radiation Council are those with which the Atomic Energy Commission and other federal agencies must comply. An objective view is presented of some of the many problems, hypotheses, and assumptions that underlie the positions of those critical of the radiation-exposure standards and guidelines, as well as those who maintain staunchly that the recommended dose levels are adequately low. It is concluded that there is no need to adjust the guidelines at present. Current contamination levels are so low, relative to the guidelines, that exposure levels will not reach 10% of the recommended guideline limits during the next few decades. Consequently, even if future research indicated a need for the full 10-fold reduction recommended by the critics, the average population dose would still be below reduced guidelines. 22 references. (auth)

60129 PUBLIC OPPOSITION TO NUCLEAR POWER: AN INDUSTRY OVERVIEW. **Slater, H. G. Nucl. Safety; 12: No. 5, 448-56(Sep-Oct 1971).**

The recent history of public and press attitudes toward nuclear power and its effect on the environment can be traced in the results of polls, panel meetings, debates, etc. Although opposition is not the rule, the quick response by the nuclear industry to the environmentalists' positions has helped to improve public relations. Since nuclear technology is involved in these complex problems, its leaders must do all they can to inform the public and to respond with candor to important questions so that mutual trust and understanding may prevail. 24 references. (auth)

60130 HTGR SAFETY. Kaplan, S. I. (Oak Ridge National Lab., Tenn.). Nucl. Safety; 12: No. 5, 438-47(Sep-Oct 1971).

For a high-temperature gas-cooled reactor (HTGR), the postulated accident mechanisms that carry population-safety significance are those which either increase the releasable fission-product inventory of the primary system or those which release the primary-system contents to the environment. Nominally these mechanisms comprise loss of coolant, graphite oxidation, loss of forced circulation of coolant, reactivity excursions, and core blockage. However, the specific multiple lines for safeguarding against all these accident mechanisms which are postulated for a large HTGR render the probability of their occurrence extremely low. Safety-directed research has provided a good general understanding of the major fission-product escape and transport mechanisms, core physics, and graphite-oxidation phenomena, although much detailed experimental information is still needed before rigorous predictions of coolant chemistry and fission-product behavior for new designs become feasible. Future research paths will be influenced by the shifts in relative importance of certain accident mechanisms as reactor size increases, by increased public pressure to minimize all radioactive releases, and by new developments in fuel and component design. 41 references. (auth)

60131 LIGHT-WATER-REACTOR SAFETY. Bright, G. O. (Idaho Nuclear Corp., Idaho Falls). Nucl. Safety; 12: No. 5, 433-8(Sep-Oct 1971).

Light-water-reactor safety problems are primarily associated with the large power reactors now being constructed. Consideration of these complex systems has resulted in the development of a Water-Reactor Safety Program Plan which represents an industry-wide consensus on issues, needs, and priorities. The principal issues are identified as development and confirmation of analytical techniques for design and safety evaluation. Specific areas of greatest importance are emergency core-cooling capability, fuel-failure phenomena under abnormal conditions, and development of needed standards and quality-assurance procedures. Current and planned future programs should provide adequate capability for solution of problems that can be identified at present, but safety is a moving target and, as reactor design advances, a continuing program is foreseen. 13 references. (auth)

60132 LMFBR SAFETY. Rose, David (Argonne National Lab., Ill.). Nucl. Safety; 12: No. 5, 421-33(Sep-Oct 1971).

The research effort and recent results of the major research and development programs of the U. S. Atomic Energy Commission and of U. S. industry for LMFBR safety are reviewed. The safety program for the liquid-metal-cooled fast breeder reactor stresses accident prevention and the early detection and control of potential accidents. The main areas of interest include the investigation of fuel behavior and of fuel-failure propagation, the understanding of the phenomena involved in reactivity accidents and the development of techniques to assess their effects, the mechanical responses of reactor systems to accidents, and the containment of the consequences of postulated accidents. 61 references. (auth)

60133 FAULT TREE ANALYSIS WITH PROBABILITY EVALUATION. Crosetti, Paul A. (Douglas United Nuclear, Inc., Richland, Wash.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 465-71(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Reliability analysis is playing an increasingly important role in quantitative assessment of system performance for assuring nuclear safety, improving plant performance and plant life, and reducing plant operating costs. In particular, fault tree analysis with probability evaluation provides an all inclusive, versatile mathematical tool for analyzing complex systems. Its application can include a complete plant as well as any of the systems and subsystems. Fault tree analysis provides an objective basis for analyzing system design, performing trade-off studies, analyzing common mode failures, demonstrating compliance with AEC requirements, and justifying system changes or additions. The logic of the approach makes it readily understandable and, therefore, it serves as an effective visibility tool for both engineering and management. 7 references. (auth)

60134 ELRAFT A COMPUTER PROGRAM FOR THE EFFICIENT LOGIC REDUCTION ANALYSIS OF FAULT TREES. Semanderes, Stavros N. (Westinghouse Electric Corp., Pittsburgh). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 481-7(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

ELRAFT is a FORTRAN program which formulates the simplest logic expression for each secondary event in a fault tree in terms of the basic events which combine to cause it. Each secondary event is expressed as the union of intersections of basic events; dependencies are eliminated by insuring that in a particular intersection, a basic event can appear only once, and a particular intersection of basic events is unique and is not a subset of another intersection of events. The property of prime numbers as expressed in the unique factorization theorem of number theory is utilized to eliminate dependencies. Each basic event is assigned a prime number and a particular combination of basic events can be expressed uniquely by a single number which is equal to the product of the prime numbers corresponding to the basic events. The output includes the event probabilities and a listing of the combinations of events causing failure arranged by single failures, then double, triple, etc. Input is quite simple with only one card for each event in the tree containing the description and location of the event and its failure probability (the latter for basic events only). The program can handle very large fault trees utilizing the CDC 6600 computer, and the computing time is independent of the probabilities involved. An exact evaluation can be obtained in seconds where a simulation might require many minutes to get an approximation. The existing program is designed to handle fault trees which use only AND and OR logic gates. It could, however, be extended to handle any type of logic gate for which there is a mathematical probability equivalence. 4 references. (auth)

60135 SYSTEMATIC APPROACH TO SAFETY DESIGN AND EVALUATION. Salvatori, Romano (Westinghouse Electric Corp., Pittsburgh). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 495-504(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The concept of probabilistic analysis is recommended as a practical tool for developing design criteria and goals. The proposed procedure and the basic principles are developed in detail. Practical applications of the probabilistic approach are included. 5 references. (auth)

60136 SAFETY ASPECTS OF FAST REACTORS. Farmer, F. R. (United Kingdom Atomic Energy Authority, Risley, Eng.). Elec. Rev.; 189: No. 9, 295-6(Aug 1971).

Features of fast breeder reactors which differ from those of thermal reactors are discussed in relation to reactor safety. Fundamental factors which assist safe operation are nondependence on auxiliary supplies after shutdown, and the low pressure of the Na coolant system. (UK)

Power Conversion Systems

60137 (KFK-1409) CLOSED GAS TURBINE CYCLE FOR A 1000-MWe GAS-COOLED FAST BREEDER REACTOR. Savatteri, C. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). May 1971. 86p. (In German). (EUR-4578). Dep. NTIS (U. S. Sales Only).

Progress in reactor technology permits reactor outlet temperatures exceeding 700°C in the case of gas-cooled fast breeders. These temperatures meet the requirements of a gas turbine. To obtain design characteristics for the final rating of a 1,000 MW(e) plant with a helium turbine, which is coupled in a direct circuit with a helium-cooled fast breeder reactor, the influence of the following parameters on process efficiency is investigated: turbine inlet temperature, compressor inlet temperature, minimum temperature difference of the heat exchanger, primary pressure, pressure loss and number of intermediate coolings. Arguments are discussed relative to the design to be selected for the turboset and the heat exchanging equipment. The pressure loss occurring in the piping system is determined and a fully integrated arrangement of the plant components is described. 38 references. (auth)

60138 (N-71-19497) SNAP-8 REFRACTORY BOILER DEVELOPMENT. TOPICAL REPORT 3: EVALUATION OF SNAP-8, SN-1 BOILER. Henderixson, W. H.; Harrison, R. W. (General Electric Co., Cincinnati, Ohio. Space Div.). 3 Nov 1970. Contract NAS3-10610. 55p. (NASA-CR-72814; GESP-550). NTIS.

The SNAP-8, SN-1 boiler which was designed and fabricated by NASA was performance tested for 13,500 hours. After testing the boiler was removed from the test facility and the boiler materials were evaluated. The evaluation indicated excellent compatibility of the boiler materials with liquid metals at high temperatures and all indications point to the design life capability of 40,000 hours. (auth) (STAR)

60139 COMBINED HELIUM AND STEAM CYCLE FOR NUCLEAR POWER PLANTS. Kilaparti, S. R.; Nagib, M. M.

XUM

(Illinois Inst. of Tech., Chicago). Mech. Eng.; 93: No. 8, 14-18(Aug 1971).

An improvement of the combined thermal efficiency is achieved above the thermal efficiency of either the gas or Rankine cycle. The most favorable combination is found to be between a simple gas cycle with no intercooling or reheating and a simple Rankine cycle. The efficiency improvement under these conditions amounts to about 10 points at a compressor pressure ratio of 3.5. This does not represent the highest possible efficiency obtained with the combined cycle. Greater improvement could be achieved through the use of one reheating in the gas cycle. This, however, is connected with complication in the cycle arrangement. It is believed that, for very large power outputs (i.e., 2000 MW(e) and above), such a combined-cycle arrangement represents a successful and probably economic solution. 3 references. (auth)

60140 TOMMORROW'S PLANT: GAS TURBINES, NUCLEAR POWER, DRY COOLING. Fortescue, Peter (Gulf General Atomic Inc., San Diego, Calif.). Power Eng.; 75: No. 8, 45-7(Aug 1971).

The operating characteristics of a power reactor utilizing a closed cycle gas turbine and secondary air cooling system are described. The closed cycle gas turbine power system described operates on a Brayton cycle. (D.C.C.)

60141 POWER PLANTS. Jubb, Albert; Ward, Robert George; Hurst, James Norman; Holliday, John Bertram; Ashley, James Wilfred (to Rolls-Royce Ltd.). British Patent 1,242,528. 11 Aug 1971. Filed 1 Nov 1967.

Reference is made to closed cycle gas turbine nuclear power plants. In the system described the compressor, the turbine and heat exchangers are located within a cavity in the wall of the reactor pressure vessel, and the compressor and turbine are removable from the pressure vessel independently of the reactor. Provision may also be made for removal of the heat exchangers. A common supporting structure for the removable components may comprise a cylindrical "pod," with cooling means. Details are given of the constructional features of the components and their interconnections. (UK)

60142 EXAMPLES OF STRESS ANALYSIS OF STRUCTURES BY FINITE ELEMENT METHOD. EXAMPLES OF THERMAL STRESS ANALYSIS AND INPUT AND OUTPUT DATA OF STEAM-GENERATOR, ETC. Mori, Koichi; Nakai, Yasuo; Nagato, Kotaro; Sasaki, Takashi; Takenaka, Yutaka (Kawasaki Heavy Industries, Ltd., Kobe, Japan). FAPIG (Tokyo); No. 59, 182-7(Nov 1970). (In Japanese).

For economical and mechanically reliable design of nuclear power plants, it is necessary to make detailed stress analysis of their components, such as boilers, pressure vessels, etc., based on detailed analysis of temperature and stress distributions. But these detailed numerical analyses are difficult in practical problems, even though a machine is employed. To cope with this difficulty, finite element method is used as the most practical strategy. Some applications of the finite element method to nuclear vessels and components using calculation programs for stress analysis and for heat conduction are presented. Computational complexities arising in the use of the finite element method are analyzed. (Japan)

60143 IMPROVEMENTS IN OR RELATING TO POWER GENERATING PLANTS. (to Babcock Atlantique). British Patent 1,242,627. 11 Aug 1971. Priority date 29 Nov 1968, France.

HEAT—storage methods for, during power plant reduced load operation

NUCLEAR POWER PLANTS—power generation cycle for, with means for storing heat during reduced load operation (H.D.R.)

60144 STEAM GENERATOR, PARTICULARLY FOR PRESSURIZED WATER NUCLEAR REACTORS. Michael, Horst; Schabert, Hans-Peter (to Siemens Aktiengesellschaft). U. S. Patent 3,603,383. 7 Sep 1971. Priority date 25 Mar 1967, Germany.

A steam generator particularly for pressurized water reactors includes an elongated pressure vessel, a bundle of heat exchanger tubes located in the vessel and extending substantially parallel to one another in the longitudinal direction of the vessel, and a pair of spaced-apart tube support plates mounted in the vessel and formed with recesses wherein respective ends of the tubes extend. The tubes are spaced from one another a distance that is only a fraction of the diameter thereof, and have a reduced diameter over a length thereof of several decimeters adjacent to the tube support plates. (Official Gazette)

60145 GAS TURBINE FOR A NUCLEAR POWER PLANT. Bammert, K.; Rehbach, J. (Inst. of Turbomachinery and Gasdynamics, Hanover). Atomkernenergie: 18: No. 2, 121-30(1971).

Problems which arise in designing the turboset of a nuclear gas turbine plant are explained by the example of a 25-MW(e) pilot power plant in which the heat source is a high-temperature reactor and the working agent is helium. While experience with closed-cycle air turbine plants and measuring results obtained in these can be used as a basis, the use of helium, which in direct-cycle operation may carry activated particles also to the turboset, poses new design problems. The high velocity of sound in helium and the high thermal conductivity of this gas allow favorable dimensions of the machines, full utilization of the materials and considerable cooling effects, which in turn allow high turbine inlet temperatures. These thermodynamic properties are favorable. On the other side there are difficulties of a hitherto unknown kind. For achieving low leakage rates, welded casings and lip seals at the partition joints are required. The helium turboset demands more stages and thus slimmer rotors, and special care during starting and stopping. The turbine casing is provided with internal insulations which must not be subject to abrasion. The helium turbine is provided with a casing cooling, a rotor hub cooling, and a blade foot cooling system to keep the temperatures of the rotor blade and rotor disc materials in the first stages within limits. In a helium atmosphere, activated gaseous foreign matter can cause corrosion and sliding surfaces tend to be cold-welded. Detailed explanations are given as to how these difficulties are mastered and how the new problems of lubricating-oil supply, oil-helium separation, retention of the working agent by means of the shaft labyrinths, sealing at the outer shaft passage opening during rotation, and standstill, etc., have been solved by proven design methods. The statements made on the control system cover the starting, normal operation with load changes, and stopping of the plant. (14 references) (auth)

60146 NUCLEAR REACTOR INSTALLATIONS. Birch, William; Powell, Christopher (to United Kingdom Atomic Energy Authority). U. S. Patent 3,600,278. 17 Aug 1971. Filed 1 Mar 1968.

A nuclear reactor is described which has vertically extending fuel tubes which terminate in a pond above the core. A flexible tube plate is penetrated by the fuel tubes and forms the base of the pond containing structure. The tube plate is supported from flanges on the tubes. (auth)

60147 STEAM-GENERATING INSTALLATION. (to Siemens Aktiengesellschaft). British Patent 1,247,228. 22 Sep 1971. Priority date 17 Apr 1968, Austria.

BOILERS—design characteristics of superheating reactor core vessel

REACTORS, SUPERHEATING—steam generators in, core vessel arrangement for (D.C.C.)

Research and Test Reactors

Refer also to abstracts 57320, 57875, 57899, 58349, 59639, 59661, 60005, 60035, 60036, 60043, and 60055.

60148 (AI-69-Memo-95) ANALYSIS OF AEROSOL BEHAVIOR FOR FFTF HYPOTHETICAL ACCIDENTS. Koontz, R. L.; Baurmash, L. (Atomics International, Canoga Park, Calif.). 28 Oct 1969. 65p. Dep. NTIS.

The distributions of the released mass of fuel, fission products, fuel cladding, and sodium coolant within the FFTF containment volumes following several postulated accidents are estimated. The mass leaking from the inner and outer vessels is computed assuming various leak rates from each compartment of the containment system. (15 references) (auth)

60149 (ANCR-1002) SUMMARY OF ETR CRITICAL FACILITY SAFETY ANALYSIS INFORMATION. Knight, D. W.; Kaufman, N. C.; Henscheid, J. W. (Aerojet Nuclear Co., Idaho Falls, Idaho). Jul 1971. Contract AT(10-1)-1375. 55p. Dep. NTIS.

A review of possible accidents at the Engineering Test Reactor Critical Facility (ETRC) shows that no credible accident would introduce a step reactivity insertion greater than 1.0$. Accidents of this magnitude would result in a total energy release far less than the minimum energy release (35.5 MW-sec) required to damage the core. All calculations are shown to be very conservative. Even though no accident mechanism can be conceived which could cause a fuel element to completely melt, the consequences of this accident are considered to be the maximum possible. It is shown that if a fuel element which had been used for an ETR flux run were to melt in the ETRC, no hazard would be presented to ETRC personnel, NRTS personnel, or off-site personnel. In addition the following conclusions were reached: (1) The conclusions of the original ETRC hazards report remain valid. (2) None of the changes which have been made to the reactor control system, the control rods, or to the fuel elements have increased the risk level associated with the operation of the ETRC. (3) New calculational techniques and information gathered since the ETRC achieved criticality support the original conclusion that the operation of the ETRC does not present a hazard to ETRC operating personnel or to personnel at the Test Reactor Area (TRA), NRTS, or off-site. 22 references. (auth)

60150 (DOCKET-50184-32) NATIONAL BUREAU OF STANDARDS REACTOR. Operations Report, January 1–June 30, 1971. (National Bureau of Standards, Washington, D. C.). 7 Oct 1971. 13p. Dep. NTIS.

60151 (DOCKET-50184-33) NATIONAL BUREAU OF STANDARDS REACTOR. Replacement to Primary System Main Heat Exchanger. (National Bureau of Standards, Washington, D. C.). 7 Oct 1971. 2p. Dep. NTIS.

60152 (DOCKET-50231-96) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Technical Specifications, Proposed Change No. 7. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 8 Oct 1971. 19p. Dep. NTIS.

Revised technical specifications are presented concerning personnel responsibilities and administrative controls. (D.C.C.)

60153 (DOCKET-50231-97) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Cladding Temperatures for the FRED Poison Rod. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 4 Oct 1971. 15p. Dep. NTIS.

60154 (DOCKET-50231-98) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Ninth Quarterly Plant Operation Report, May 1–July 31, 1971. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 8 Oct 1971. 26p. Dep. NTIS.

60155 (DOCKET-50231-99) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Technical Specifications Proposed Change No. 8. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 16 Oct 1971. 31p. Dep. NTIS.

Revised technical specifications are presented concerning Core 2 transient test program. (D.C.C.)

60156 (GULF-RT-A-10800) FAST REACTOR SPECTRUM MEASUREMENTS. Quarterly Progress Report, May 1, 1971–July 31, 1971. Young, J. C.; Slaggie, E. L.; Neill, J. M.; Verbinski, V. V. (Gulf Radiation Technology, San Diego, Calif.). 20 Aug 1971. Contract AT(04-3)-167. 20p. Dep. NTIS.

The work performed during the second quarter of 1971 on a continuing program of neutron spectrum measurements in subcritical assemblies (STSF) is described. All the planned experimental measurements on the first core to be studied (STSF-9) were completed. Further calculations for this core are also reported. 13 references. (auth)

60157 (INR-1316) PRIMARY COOLANT PURIFICATION SYSTEM IN THE EWA-10 REACTOR. Bieguszewski, Zygmunt (Institute of Nuclear Research, Warsaw (Poland)). 1971. 20p. (In Polish). Dep. NTIS (U. S. Sales Only).

The filter unit used for removal of ionic, colloidal, and discrete solid particles from the primary coolant water is described. It comprises mixed bed ion exchange column, electrophoretic filter, and mechanical filter with cylinder filtering element. The performance data and experience in reactor water purification system operation are outlined, covering the period 1967 to 1970. 5 references. (auth)

60158 (ORNL-TM-3514) EXPERIMENTAL INVESTIGATION OF NEUTRON STREAMING THROUGH THE GRID-PLATE SHIELD OF THE FAST FLUX TEST FACILITY. Clifford, C. E.; Mynatt, F. R.; Stevens, P. N. (Oak Ridge National Lab., Tenn.). 5 Oct 1971. Contract W-7405-eng-26. 41p. Dep. NTIS.

An experiment was performed at the Tower Shielding Facility (TSF) to determine the effect of neutron streaming in sodium coolant holes on the peak neutron fluence transmitted through a prototype of the FTR grid-plate shield. Three grid-plate shield configurations were used in the experiment, each having different hole configurations. A flux increase of about 10% was measured for straight-through holes and a 3% increase was measured for holes having a single offset. Standard deviations of measurements obtained were approximately 2%. 6 references. (auth)

60159 (RCN-150) DETERMINATION OF EFFECTIVE CROSS SECTIONS OF FISSION PRODUCTS FOR FAST BREEDERS IN THE FAST-THERMAL COUPLED CRITICAL REACTOR STEK. Bustraan, M. (comp.) (Reactor Centrum Nederland, Petten). Jul 1971. 26p. Dep. NTIS (U. S. Sales Only).

The influences of fission products on fast breeder reactors are outlined. A description is given of the fast-thermal coupled facility STEK. Integral measurements of fission product cross sections by a sample oscillator technique in fast reactor spectra are described. A review is given of the available samples, including some highly active samples of actual fission products. One of the methods used to measure the neutron spectrum in the center of the fast zone is the time-of-flight technique. The results of central reactivity worth measurements in the first two cores — STEK-4000 and -3000 — are presented and compared with calculations. The calculated and measured fast neutron spectra in the sample position are also given. Some techniques are mentioned for adjustment of the differential cross section values with the results of the integral measurements. 28 references. (auth)

60160 (STI/DOC-10/127) DETERMINATION OF ABSORBED DOSE IN REACTORS. (International Atomic Energy Agency, Vienna (Austria)). 1971. 261p. IAEA $7.00.

The requirements for absorbed dose determination in low atomic number materials in reactor cores are discussed. The materials include graphite, water, carbon dioxide, and hydrocarbons. Reactor radiation, reactor dosimetry problems, radiation spectra, and the calculation of absorbed dose are described. Experimental methods for the measurement of absorbed dose in reactors, including calorimetry, ionization chambers, and chemical and solid state dosimetry, are surveyed. 361 references. (H.D.R.)

60161 TEMPERATURE EFFECT IN THE 20 TO 250°C RANGE FOR CERTAIN, STRICTLY REGULAR, HETEROGENEOUS, U–H_2O CRITICAL ASSEMBLIES. Bat, G. A.; Gulimov, V. N.; Zarubin, Yu. V.; Obukhov, V. K.; Ushakov, Yu. V. At. Energ. (USSR); 30: No. 4, 354-8(Apr 1971). (In Russian).

Due to little experimental data, the temperature dependence of criticality is calculated with an error of at least 20%. In order to remedy this situation, experiments were carried out with unperturbed, uranium–water systems within a wide range of ^{235}U from $\rho_H/\rho_5 \approx 50$ to 600, and at temperatures from 20 to 250°C. Four fuel elements with different amount of uranium were used in the experiments; above 90°C only elements containing 40.5 g ^{235}U were employed. The sectional elements consisted of zirconium-canned units within a steel housing. Space was left for the control rods in the water between the fuel elements. It was found that the critical loading G^{235} depends only slightly on the uranium concentration of the fuel. A hardening of the thermal neutron spectrum was noted when large-step lattices were heated. The experimental data agreed with the calculations when the system was heated above 200°C; errors may be reduced by using an improved computer program which implies homogenization of the lattice in a four-group approximation. (TTT)

60162 KINETIC DISTORTION IN A TRIGA REACTOR WITH AN ASYMMETRIC REFLECTOR. El-Zeftawy, Medhat M.; Ruby, Lawrence (Univ. of California, Berkeley). Nucl. Sci. Eng.; 45: No. 3, 335-41(Sep 1971).

The prompt and delayed flux shapes in the TRIGA Mark III reactor with an asymmetric reflector can be calculated in a straightforward manner using a standard multigroup diffusion code. A semiempirical kinetic distortion factor has been shown to be consistent with theoretical predictions based on such a calculation. It is concluded that for water-reflected assemblies, standard pulse-neutron methods will yield a less spatially dependent value of the reactivity if a relatively small, readily obtained kinetic distortion correction factor is applied. (auth)

60163 INTEGRAL REACTION RATE DETERMINATIONS. PART I. TAILORED REACTOR SPECTRUM PREPARATION AND MEASUREMENT. Draper, E. Linn Jr. (Cornell Univ., Ithaca, N. Y.). Nucl. Sci. Eng.; 46: No. 1, 22-30(Oct 1971).

Four different epicadmium neutron flux spectra were produced by boron filter insertion in a beam port of the Cornell University 100-kW TRIGA reactor. The first spectrum was the unaltered (except for cadmium covers) fission slowing down spectrum; three hardened spectra were produced by the insertion of boron filters enriched in ^{10}B. The shapes and amplitudes of the spectra were determined by the computer code SAND II to reproduce foil activation data obtained from a set of resonance and threshold detectors. (auth)

60164 STUDIES ON THE HEAT TRANSFER DYNAMIC ANALYSIS AND THE STABILITY OF TRIGA MARK-II REACTOR.

Park, Yong Chip; Yook, Chong Chul; Park, In Yong. Hanyang Univ. Res. Works Grad. Sch.; 5: 214-23(1969).

The heat transfer dynamic analysis of TRIGA Mark-II reactor with cylindrical fuel elements is derived under some assumptions of the fuel rod temperature effects and coolant water temperature effects on reactor feed back into reactor reactivity at 100 kW power level. Coolant water temperature variations are taken into consideration. The over all closed loop reactor transfer function is analytically calculated and it is compared with the measured value in Bode diagram by experimental data. The reactor dynamics and the stability are analyzed by means of the root locus. (Korean Sci. Abstr.)

60165 STUDY OF SAFETY ROD MOVEMENT DURING SCRAM IN THE ZfK ROSSENDORF RESEARCH REACTOR. Nagel, S. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie; 14: No. 5, 152-6(May 1971). (In German).

Shut-down movement of safety rods was studied on a complete scram mechanism of the Rossendorf WWR-SM research reactor. The experimental equipment enables detailed registration of path-time curve and, with this, information on individual phases of movement (acceleration, free fall, deceleration). Measurements were carried out according to the principle of light barrier with divided gauge length. Experiments in air or water yielded a shutdown time of 380 or 400 ms for a distance of 730 or 715 mm. (auth)

60166 KINETIC PARAMETERS DETERMINATION IN A NATURAL URANIUM-LIGHT WATER LATTICE BY THE PULSED SOURCE TECHNIQUE. Lazarescu, G. A. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 16: No. 3, 375-9(1971).

Experiments were performed on a HELEN natural uranium-light water lattice, using the pulsed source technique, to prove that the prompt fundamental mode can be experimentally separated and its decay constant measured accurately even in the case of a far subcritical lattice. Because the prompt to delayed flux ratio is reduced and kinetic distortion very strong, it was difficult to obtain an experimental value for the reactivity in concordance with the theoretical one in this lattice. (auth)

60167 CRITERIA FOR COMPARISON OF RESEARCH REACTORS. Tsykanov, V. A. At. Energ. (USSR); 31: No. 1, 15-17(Jul 1971). (In Russian).

The lack of comparison criteria taking into account both reactor properties and their application peculiarities makes it difficult to compare different type reactors. It is useful to have such criteria for comparison of various reactors in choosing a reactor type for comparative evaluation of operating reactors. Such criteria are proposed for an extensive class of reactors in which the neutrons produced are used to irradiate specimens. One of the proposed criteria characterizes the productivity of a reactor and another one accounts for its economic parameters. The latter criterion may be considered as an ideal efficiency of a research reactor. For taking into account of reactor economy more completely the fuel burnup level and the reactor time utilization factor should also be used. (auth)

60168 VVR REACTOR SEMIAUTOMATIC ACTIVATION ANALYSIS SYSTEM. Lisovskii, I. P.; Smakhtin, L. A.; Filippova, N. V.; Volgin, V. I. This paper was summarized in At. Energ. (USSR); 29: No. 6, 450(Dec 1970) as paper No. 450/5821. (In Russian).

A semiautomatic pneumatic shuttle system for a nuclear reactor is described. The specimens were irradiated in hermetically sealed polyethylene capsules which were placed in the shuttle rabbit. After ten rabbits with specimens have been placed in the loader, all further operations (irradiation exposure, extraction of capsule with specimen from the rabbit and delivery of specimen to the laboratory for measurements) are handled automatically. The total time elapsed from the end of the irradiation exposure to the beginning of measurements is 10 to 20 sec (depending on the size of the capsules). Work done in activation analysis with the aid of this semiautomatic shuttle and irradiation system is reviewed. Operating experience with this pneumatic shuttle, over a four-year period, has demonstrated the versatility, reliability, and ease of operation of the system. 12 references. (auth)

60169 SYSTEM FOR AUTOMATIC STARTUP AND POWER REGULATION OF RESEARCH REACTORS. Khasan, M. A.; Sisevich, I. G. At. Energ. (USSR); 31: No. 1, 11-15(Jul 1971). (In Russian).

A time suboptimal control system for start-up and power level changes in research reactors is given. The control signal is chosen in such a way to not violate the safe exploitation conditions. Object dynamics is described by two differential equations and the Maximum principle used as a guide to the choice of control signal. To solve the synthesis problem for the system physical considerations are used instead of complex mathematical conditions. A system of the above type is implemented on a reactor of the WWR-S type. The implementation required little change in the standard reactor control system. The required additional blocks were developed on semiconductor components. A general system block diagram, diagrams of individual blocks, and a description of the system working sequence are included. (auth)

60170 EXPERIMENTAL STUDIES OF POWER INCREASE IN In-Ga RADIATION LOOPS. Kiknadze, G. I.; Bedbenov, V. B.; Lyudvigov, R. B.; Sharimanova, L. G. At. Energ. (USSR); 31: No. 2, 113-18(Aug 1971). (In Russian).

A neutron flux distribution representing the leakage from the nuclear reactor core is investigated in different heterogeneous indium-graphite assemblies (models of radiation loop activity generators). It is shown that the specific and total power of a radiation loop may be increased when activity generators are designed in the form of multilayer systems consisting of thin layers of the gamma-carrier ($\Sigma_a d \ll 1$) arranged with the definite pitch in the moderator. Five experimental models of the activity generator of the radiation loop have shown that for thick blocks of the indium absorber the value of the radiation power of the gamma carrier is mainly caused by thermal neutrons and only for layer thickness of the gamma-carrier of $\lambda_a/16$ and less resonance neutrons contributed appreciably to the induced radioactivity. 10 references. (auth)

60171 SOME INTEGRAL-REACTIVITY PROPERTIES AND THEIR APPLICATION TO THE IGR REACTORS. Lavrenikov, V. D. This paper was summarized in At. Energ. (USSR); 29: No. 4, 283(Oct 1970) as paper No. 430/5683. (In Russian).

The integral reactivity is a parameter having a very similar character for all reactors and may be used successfully in studying reactor dynamics. On transforming the equation of reactor dynamics by changing the argument (time replaced by heat evolution), the integral reactivity may be expressed in terms of the reactor power. It is shown that, in the case of IGR reactor, the proper application of integral reactivity properties increase the accuracy of calculating the heat evolution at the reactor shutdown, and sometimes give a fairly simple analytical solution. In addition to this, the integral reactivity may be used in order to calculate the surge parameters which are particularly important for this reactor: the dependence of the total heat evolution, and also the reactivity at the final stage of the surge, on the initial reactivity. It is shown that the integral reactivity may be employed when measuring the thermal coefficient of reactivity of the IGR reactor. (auth)

60172 MICRODISTRIBUTION OF FISSION DENSITY IN VVR-M (WATER-COOLED WATER-MODERATED REACTOR) CRITICAL-ASSEMBLY LOOP CONVERTER CELLS. Klimentov, V. B.; Kopchinskii, G. A.; Bobkov, V. G. This paper was summarized in At. Energ. (USSR); 29: No. 4, 283(Oct 1970) as paper No. 429/5737. (In Russian).

The possibilities of carrying out loop tests in thermal reactors with many-element assemblies of highly-enriched fuel elements are limited by the serious nonuniformity of the energy evolution and fuel consumption (burnup). In order to study the conditions of reactor tests on many-element loop assemblies, the microdistributions of fission density were measured along the radius and on the surface of the central and peripheral model fuel elements in a seven-element fuel assembly, using the method of autoradiography in a critical VVR-M test system. Rods made of tablets of uranium dioxide (90% enriched) 0.9 cm in diameter were used as model fuel elements. 5 references. (auth)

60173 OPERATING EXPERIENCE AND RESULTS OBTAINED WITH THE TRIGA RESEARCH REACTOR AT THE GERMAN CANCER RESEARCH CENTRE. Krauss, O.; Lorenz, W. J.; Maier-Borst, W.; Ostertag, H.; Wolber, G. (Deutsches Krebsforschungszentrum, Heidelberg). Kerntech. Atompraх.; 13: No. 7-8, 307-13(Jul-Aug 1971). (In German and English).

Operating experience and the results obtained with the reactor TRIGA Mark I in the Nuclear Medicine Institute of the German Cancer Research Center in Heidelberg are reported. The irradiation facilities and the experimental peripherals of the reactor are described in some detail. Recent results are reported on the use of the reactor in nuclear medical cancer research and in clinical practice. A discussion of the design alterations of the reactor in the final construction stage is included. 30 references. (auth)

60174 EXPERIMENTAL FAST REACTOR JOYO. FUEL HANDLING SYSTEM. Ohno, Tadao (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 17: No. 2, 20-2(Feb 1971). (In Japanese).

Fuel handling system of "Joyo" consists of the following parts:

fuel replacing machine for the purpose of replacing and transferring fuel in the reactor container, loading and unloading machine, transfer-rotor at boundary of the container to play a part of intermediary base at the time of transferring fuel, and fuel storage system outside the container. Main conditions for design are determined as follows: fuel cycle of operation for 45 days and stop for 15 days; maximum quantity of fuel replacement at each cycle of 20 rods; cooling time in the reactor for spent fuel of 45 days; decay heat at the time of unloading fuel out of the reactor of 1.5 kW; and in-pile sodium temperature at the time of fuel replacement of 250°C. It may be said that most of the problems peculiar to "Joyo" result from sodium. (Japan)

60175 EXPERIMENTAL FAST REACTOR JOYO. COOLING SYSTEM. Abe, Yasuhiro (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 17: No. 2, 13-17(Feb 1971). (In Japanese).

Cooling of the EFR "Joyo" consists of primary Na cooling systems to remove heat from the reactor core, intermediate heat exchangers, and secondary Na cooling systems to dissipate heat to the atmosphere. The overall cooling system is of two loops. Both the primary and the secondary systems are provided with an auxiliary system to be used in maintenance and trouble in main cooling systems. The primary system is of double-walled pipes to cope with Na leakage. The primary cooling system is within a containment vessel, nitrogen gas atmosphere is provided around the Na system; and no water is involved in buildings containing the Na systems. The following are described: constituents of the cooling loops including the primary and secondary systems, overflow, purification, cover gases, pumps, heat-exchangers, piping, pre-heating, etc.; aseismatic design, purities of structural materials, sodium, etc.; and operation, maintenance, accident, etc. (Japan)

60176 EXPERIMENTAL FAST REACTOR JOYO. COMPONENTS OF CORE. Ohno, Tadao (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 17: No. 2, 17-19(Feb 1971). (In Japanese).

The core is composed of 313 components, i.e., 67 fuel assemblies, 6 control rods, 191 radial blanket assemblies, 1 neutron source and 48 reflectors. The fuel assembly is composed of 91 fuel elements in which mixed oxide pellets sandwiched by depleted uranium oxide pellets are contained in a stainless steel fuel clad. An interval of each fuel element is maintained with wrapping wire. The radial blanket assembly is composed of 19 fuel elements with depleted uranium oxide pellets. The reflector material is stainless steel. The control rod is composed of 7 control rod elements, in which sintered B_4C pellets are contained in a stainless-steel clad. Because of high temperature and high heat flux, creep effect and thermal ratcheting becomes important. Because of high level irradiation with fast neutrons, swelling of stainless-steel and irradiation embrittlement present problems. Mass-transfer phenomenon by sodium medium and corrosion by sodium are also important. (Japan)

60177 EXPERIMENTAL FAST REACTOR JOYO. MECHANICAL FEATURES (REACTOR PROPER). Hirota, Isao (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 17: No. 2, 9-13(Feb 1971). (In Japanese).

The reactor proper of the sodium cooled EFR "Joyo" broadly consists of the following: a reactor vessel hung from upper pit end; core structure in it; rotary plugs to serve both as top shield and mechanism for horizontal fuel movement; and control-rod drive sets through the rotary plugs. Among other components are a fuel exchanger for exchanging fuels between in-pile storage rack and reactor core, a fuel transport for exchanging used and new fuels, a graphite shield serving also for in-pile sodium containment, and a safety vessel containing the graphite shield. The following are described: functions of nuclear reaction control, heat removal, fuel exchange and shielding; the reactor vessel, reactor core structure, rotary plugs, control-rod drive, and safety vessel and graphite shield; and problems including safety rod dropping in earthquakes, heat deformation of the reactor-vessel, sodium adhesion between the rotary plugs and the reactor vessel, and regulating-rod vibration during reactor operation. (Japan)

60178 SORA REACTOR PROJECT. Energ. Nucl. (Paris); 13: No. 3, 229(May 1971). (In French).

The chronological development of the SORA reactor project is presented. The advantages of a pulsed reactor are examined. (France)

60179 FEEDBACK BEHAVIOR OF THE PROMPT MODERATOR HEATING EFFECT. Ishikawa, Michio. Nippon Genshiryoku Gakkaishi; 13: No. 8, 430-9(Aug 1971). (In Japanese).

SPERT-III • E-Core transient tests demonstrated that under certain reactor conditions the prompt moderator heating (PMH) effect significantly attenuates the reactivity added during the fast burst power period. The behavior of the PMH feedback effect is examined through both qualitative analysis based on theoretical considerations and a quantitative analysis on the SPERT-III transient tests obtained with EUREKA, a multi-region, nuclear kineto-thermohydrodynamic code. The marked effects brought upon power reactor kinetics by the PMH feedback are discussed. (auth)

60180 TARGET FOR THE AEC'S REACTOR STANDARDS PROGRAM IN THE INSTRUMENTATION AND CONTROL AREA. Havenstein, Paul L. (Division of Reactor Development and Tech., Washington, D. C.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 332-6(Feb 1971).
From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The development of standards for the FFTF instrumentation and control systems is described. (D.C.C.)

60181 INVESTIGATION OF BOILING DETECTION IN THE HFIR USING OUT-OF-CORE INSTRUMENTATION. Fry, D. N.; Kryter, R. C.; Robinson, J. C. (Oak Ridge National Lab., Tenn.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 345-50(Feb 1971).
From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Analysis of neutron fluctuations produced by coolant pressure oscillations and of neutron noise were investigated as two possible boiling detection methods during a boiling experiment in the High Flux Isotope Reactor (HFIR). Neither method detected boiling because the void volume due to boiling was 0.007 in.^{3}, which is less than the detection threshold for either method. 12 references. (auth)

60182 PERFORMANCE OF PERMANENT MAGNET FLOW-THROUGH-TYPE SODIUM FLOWMETERS IN EBR-II INSTRUMENTED SUBASSEMBLIES. Forster, George A. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 363-5(Feb 1971).
From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The first two instrumented fueled subassemblies in EBR-II included permanent-magnet sodium flowmeters. The first operated for the duration of the test, four months, with no observable degradation. Its signal was about six percent below that calculated. The second flowmeter had been precalibrated in a sodium system. Operating data from EBR-II indicates that its sensitivity has been stable within three percent during the first 150 days in the core. Post-test examination will supply more conclusive data. 4 references. (auth)

60183 DEVELOPMENT OF AN IN-CORE PERMANENT-MAGNET PROBE-TYPE SODIUM FLOWSENSOR FOR OPERATION IN THE FAST FLUX TEST FACILITY (FFT). Verber, F.; Jaross, R. A.; Mulcahey, T. P. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 366-71(Feb 1971).
From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A permanent-magnet, probe-type sodium flowsensor small enough to be inserted and removed through curved instrumentation guide tubes and positioned above fuel assembly outlet coolant channels in the FFTF has been developed and tested in out-of-pile dynamic sodium loops. Design and construction features, test results, and improved design considerations, are presented. 6 references. (auth)

60184 EDDY-CURRENT PROBE-TYPE SODIUM FLOWSENSOR FOR FFTF REACTOR FUEL CHANNEL FLOW MONITORING. Brewer, John (Argonne National Lab., Ill.); Jaross, Robert A.; Brown, Russell L. IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 372-7(Feb 1971).
From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

An eddy-current probe-type flowsensor is being developed for FFTF to indicate sodium flow velocity at the outlet of a fuel channel in a temperature range of 300°F to 1200°F and a velocity range of 0 to 18 fps. Design considerations, out-of-reactor tests, both dry and in sodium, were performed and results are presented. Typical sensitivity of 0.6 mV rms/ft-sec has been obtained with excellent stability. 6 references. (auth)

60185 ON-LINE, DIGITAL DATA HANDLING AND OPTIMAL CONTROL INVESTIGATIONS AT THE MISSOURI UNIVERSITY RESEARCH REACTOR. Partain, C. Leon; Noyes, Clyde R.;

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Wilbur, Robert E.; Schlapper, Gerald A. (Univ. of Missouri, Columbia). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 395-402(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

An on-line, digital data handling and optimal control system based upon a PDP8s, general purpose, programmable digital computer, has been developed and tested at the Missouri University Research Reactor (MURR), a 5 megawatt, thermal, flux-trap type nuclear reactor. The instrumentation which has been successfully interfaced to the small digital computer includes a 100 channel, 250 Hz, randomly addressable reed scanner; a 10-bit, 100 kHz, analog-to-digital converter; a 60 Hz real time clock which provides a hardware interrupt every 16.7 milliseconds; and two relay contact outputs. Software which has been implemented includes a real-time executive which schedules eight different tasks in a specified priority and periodic scheme, a console utility package which allows direct, on-line, communication between computer core memory and the ASR-33 teletype, an analog signal input task, various control algorithms, an output task, and a systems log task. The automatic control algorithms are dependent upon the physical parameters of the reactor system. These parameters may be periodically identified by on-line dynamic testing and the control decision algorithm may be modified accordingly. Methods of z-transform analysis are applied in a linearized approach to the problem of representing each component of the closed-loop reactor, computer control system. The optimization theory based on the maximum principle of L. S. Pontryagin has been applied in an effort to improve the control calculations with respect to minimum time response. Testing methods used were hybrid computer simulation and on-line parameter input studies at the MURR. 14 references. (auth)

60186 LYNCHBURG POOL REACTOR PROTECTIVE SYSTEM INSTRUMENTATION. Lovallo, J. M. (Babcock and Wilcox Co., Lynchburg, Va.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 438-42(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A reliable modular protective system has been designed, tested, and installed on the Lynchburg Pool Reactor (LPR). Solid-state and integrated circuit technology has been used throughout in the design of all modules. These module designs can be easily duplicated for use at other research reactor facilities, and the system is flexible enough to accommodate changing requirements. (auth)

60187 RELIABILITY AND FAULT TREE APPLICATIONS AT THE NRTS. Vesely, W. E. (Idaho Nuclear Corp., Idaho Falls). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 472-80(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

Fault tree methods and reliability engineering techniques are used at the National Reactor Testing Station (NRTS) principally to evaluate reactor protective and safeguard systems. The particular analytical technique called "Kinetic Tree Theory," with the associated computer programs, is used to obtain quantitative probabilistic characteristics regarding the safety and reliability of these systems. Once the fault tree or block diagram is drawn, the Kinetic Tree Theory technique automatically yields detailed time-dependent information for every component, for every minimal cut set (critical path) and for the system itself. The computer time needed for this detailed analysis is negligible. In actual application, the fault tree and reliability engineering techniques, with the quantitative evaluations by Kinetic Tree Theory, have yielded results which verify the practical value of these types of safety and reliability analyses. 3 references. (auth)

60188 EXPERIMENTAL FAST REACTOR JOYO. REACTOR CONTAINER. Yuasa, Yoichi (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo: 17: No. 2, 22-5(Feb 1971). (In Japanese).

The shape of the container vessel bears resemblance to containers for pressurized light water reactors (PWR). In sodium-cooled reactors, fire due to sodium must be considered. As counter measures, vacuum-breaking valves and reinforcing rings were designed. Design load for the container is as follows: gravity including snow load; design pressure to maximum inner pressure (= 1.5 kg/cm^2g) × 0.9, minimum outer pressure (= 0.05 kg/cm^2g); load due to wind for velocity head $q = 60\sqrt{h}$ kg/m^2, where h is height from ground; load due to earthquake for vertical deviation of 0.27 g × 1.5, horizontal direction and magnitude value by dynamic analysis × 1.5; and thermal load of 150°C for upper part, and −15°C for lower part, assuming sand cushion part as boundary. Most important problem is measurement of leakage after sodium was filled up. For this problem, permissible rate of leakage was determined as 0.45% or less/day when no sodium, and 3% or less/day when sodium was filled-up. Material was determined according to ASME Code Sec. II, SA-516 Gr. 60, SA-300 Cl.1. Construction method was single stage construction. (Japan)

60189 EXPERIMENTAL FAST REACTOR JOYO. REACTOR BUILDINGS. Oike, Isao (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo: 17: No. 2, 25-9(Feb 1971). (In Japanese).

Buildings for the EFR "Joyo" are constructed on artificial foundation in sand of the Pacific coast, and are a reactor building and buildings around the reactor building, such as main cooler building for coolers of Na coolant, waste treatment, and maintenance buildings. Aseismatic design is fully taken into consideration, and the buildings are grouped in A-class buildings containing primary Na coolant, B-class buildings with secondary coolant and wastes, and C-class buildings for others. The reactor building is about 27 m high above ground and 32 m deep below it, and diameter is 31 m. The building complex around the reactor building is 50 × 55 m, and has two floors above and two in the basement. Details of these buildings including interior equipment, etc. are described. (Japan)

60190 EXPERIMENTAL FAST REACTOR JOYO. CONSTRUCTION OF REACTOR BUILDING. Shimoda, A. (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Genshiryoku Kogyo; 17: No. 2, 29-31(Feb 1971). (In Japanese).

Civil engineering works for the reactor building of the EFR "Joyo", both excavation and concrete placing, are described. Primary excavation was started in January 1970, and secondary excavation was completed in July the same year. Below −20 m G.L., a 12-m thick ferro-concrete mat and beams are used for foundation. When construction of a containment vessel is started, the concrete placing is limited to peripheral portion. After construction of shielding walls and the concrete placing within the containment vessel, the structure will reach ground level in April 1972. The construction schedule is described, and the excavation and the concrete works are explained. Depth of the excavation including the primary and secondary is about 32 m; formation there is mostly sand. In the concrete works, the shielding concrete is especially treated for controlling specific gravity. (Japan)

60191 OPERATING EXPERIENCE OF TSURUGA POWER STATION. Iwakoshi, Yonesuke (Japan Atomic Power Co., Tokyo). Karyoku Hatsuden; 22: No. 1, 24-7(Jan 1971). (In Japanese).

Tsuruga power station, the second commercial nuclear power station in Japan, was completed in 47 months from commencement of construction. The station continued power generation at availability of near 100% during peak demand period of last summer, and its reliability was highly valued. First charging of fuel began on Sept. 20, 1969, and it took 176 days to carry out fuel charging test, nuclear heating test and power raising test. Various problems encountered during trial and operation thereafter are described. Trial revealed that thermal efficiency is higher than designed value, and operating power output was increased from 322 MW to 331 MW. Satisfactory operation is continuing since March 14, 1970. Problems encountered in this period are reviewed. During periodical inspection in the fall, first fuel replacement of 48 fuel assemblies is planned. (Japan)

Rocket and Space Reactors

Refer also to abstracts 57617, 57640, and 57671.

60192 (N-71-25411) PRELIMINARY IMPACT SPEED AND ANGLE CRITERIA FOR DESIGN OF A NUCLEAR AIRPLANE FISSION PRODUCT CONTAINMENT VESSEL. Finnegan, Patrick M.; Puthoff, Richard L.; Turnbow, James W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1971. 37p. (NASA-TM-X-2245). NTIS.

Reports and photographs of 96 major accidents occurring before 1965 and involving multiengine jet aircraft were studied. Impact speed and angle are presented for landing and takeoff accidents, cruise accidents without in-flight structural failure, and in-flight structural failure accidents. The landing and takeoff accidents had an average impact velocity of 200 ft/sec from any direction and a maximum impact velocity of 300 ft/sec with a 10 deg solid angle about the roll axis. The cruise accident without structural failure had an average impact velocity of 400 ft/sec and a maximum possibility as high as 1000 ft/sec (305 m/sec), both within a 10 deg solid angle about the roll axis. The in-flight structural failure accident had an average impact velocity of 400 ft/sec

(122 m/sec) from any direction and a maximum possibly as high as 1000 ft/sec (305 m/sec) within a 10 deg solid angle about the roll axis. The in-flight structural failure accident determines the most severe impact speed for all impact angles. (auth) (STAR)

60193 (N-71-26979) ANALYTIC STUDY OF AN ELECTRIC STEPPING MOTOR DRIVE FOR A NUCLEAR REACTOR CONTROL DRUM. Kieffer, Arthur W. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). May 1971. 38p. (NASA-TM-X-2297). NTIS.

A stepping motor as a reactor control drum drive (drum weight is approximately 159 kg) is evaluated. Motor performance is evaluated for different load and motor conditions. Failure free operation, where the motor rotates one step increment for each step command, is considered most important. Failures were less frequent when stepping was at a rate that allowed the system to come to rest between steps. A failure free operating region is defined for this type of stepping rate. (auth) (STAR)

60194 (N-71-27855) THERMAL DESIGN OF THE SNAP 8 TANTALUM STAINLESS STEEL BOILER. Sellers, A. J. (Aerojet-General Corp., Azusa, Calif.). Jun 1971. Contract NAS3-13458. 105p. (NASA-CR-72760). NTIS.

The design analysis of a once through type, forced convection mercury boiler is presented. Heat and momentum transfer parameters are established as well as the internal geometry of the working fluid flow passage and overall boiler design configuration. The boiler design was based on heat and momentum transfer correlations derived from idealized wetting and non-wetting two phase flow models. Predicted performance characteristics as defined by NaK and mercury-side temperature and pressure profiles were in relatively good agreement with test results of experimental and full scale boilers. If foreign materials such as oil or air enter the system, undesirable changes in heat transfer result. (auth) (STAR)

60195 (SWRHL-78-r) FINAL REPORT OF OFF-SITE SURVEILLANCE FOR THE NRX-A6 REACTOR TEST SERIES. (Western Environmental Research Lab., Las Vegas, Nev.). Aug 1971. 46p. Dep. NTIS.

The NRX-A6 reactor test was a 60 minute full-power test under the NERVA program. The test was conducted at the Nuclear Rocket Development Station, Jackass Flats, Nevada, on December 15, 1967. The off-site radiological monitoring procedures used and the data obtained are summarized. (H.D.R.)

60196 (SWRHL-87-r) ENVIRONMENTAL SURVEILLANCE FOR PEWEE 1, EXPERIMENTAL PLANS II AND III, NOVEMBER 21 AND DECEMBER 4, 1968. Final Report. (Western Environmental Research Lab., Las Vegas, Nev.). Sep 1971. 33p. Dep. NTIS.

Radiological monitoring and sampling were conducted in off-site areas after the testing of the Pewee 1 reactor through Experimental Plans (EP's) II and III, conducted on November 21 and December 4, respectively, at Test Cell C, Nuclear Rocket Development Station. No radioactivity was released during Experimental Plan I. Following EP II, airborne radioactivity was detected by aircraft, but was not detected off-site on the ground by thermoluminescent dosimeters (TLD's) and Geiger-Mueller (GM) survey instruments or in air, vegetation and milk samples. The radioactive effluent from EP III was found by aircraft and off-site surveillance to have moved east-southeast from the test area as far as northwestern New Mexico. The effluent was not detected off-site by TLD's or GM survey instruments; however, low levels of ^{131}I, ^{132}Te-I and ^{133}I were detected on natural vegetation and air samples. Air samples which contained reactor-related radioactivity were collected in southeastern Nevada, southern Utah, southwestern Colorado, northern Arizona, and northwestern New Mexico. Emissions from reactor pulse-cool-down operations and possibly portions of the main reactor cloud transported south by the evening drainage winds were also detected by air samplers located in southeastern California and Nevada. The maximum calculated thyroid dose from the inhalation of airborne radioiodine, based on air sampling results, occurred at Las Vegas, Nevada, where the postulated child thyroid dose was less than one mrad. (auth)

60197 THERMIONIC CONVERTER CELLS FOR NUCLEAR REACTOR. Becker, Richard A.; Hill, Paul R.; Hobson, Robert R. (to United States Atomic Energy Commission). U. S. Patent 3,590,286. 29 Jun 1971. Filed 21 Nov 1968.

An improved thermionic converter cell is provided for use with a cylindrical fuel ring space power reactor. The collector of a conventional converter cell is modified to enclose a vapor chamber condenser which carries the generator heat through a beryllium oxide reflector to an external heat sink. The combination of beryllium oxide as the reflector material and vapor chamber condensers provides a radial neutron reflector which has both good nuclear properties and high effective thermal conductivity. (Official Gazette)

60198 SHUTTLE DESIGN STARTS IN OUTER ORBIT. Gregory, Daniel L. (Boeing Co., Seattle). Astronaut. Aeronaut.; 9: No. 8, 46-51(Aug 1971).

Systems concepts for low-cost space transportation are described. One component of such systems would be a reusable interorbital nuclear ferry. (H.D.R.)

60199 FUEL ELEMENTS FOR USE IN THERMIONIC NUCLEAR REACTORS. Busse, Claus A. (to EURATOM). U. S. Patent 3,601,638. 24 Aug 1971. Priority date 9 Apr 1967, Luxembourg.

Nuclear fuel-heated thermionic converters are designed in which heat pipes are provided to ensure isothermal heat transfer between the converters and the reactor. (auth)

Process Heat and Desalination Reactors

60200 CHANGE-OVER TO NEW FORMS OF ENERGY IN THE IRON AND STEEL INDUSTRY. Schenck, H.; Wenzel, W. (Rheinisch-Westfaelische Technische Hochschule, Aachen). Brennst.-Waerme-Kraft; 23: No. 6, 295-6(Jun 1971). (In German).

By adopting a well-considered energy policy it may be possible to replace the conventional processes in the iron and steel industry by direct reduction of the ore. Among the new ideas is the partially direct use of nuclear energy to provide process heat thus by-passing the production of electricity. For a steel plant of this conception it is calculated that the utilization of nuclear energy is particularly favorable. (auth)

60201 NUCLEAR POWER OPERATED DE-SALINATION OF SEA WATER UNDER NOMINAL AND PARTIAL LOAD CONDITIONS. Kunst, B. (Gesellschaft fuer Anlagenbau mbH, Essen); Gnam, E.; Regnet, K.; (and others). Brennst.-Waerme-Kraft; 23: No. 6, 290-4(Jun 1971). (In German).

The state of the art of such installations and the principal development trends are reviewed. The effects of reactor type and size are treated in detail. The main operating parameters of the nuclear power plant and desalination plant working under partial load are investigated with reference to an installation with a capacity of 400,000 m^3 fresh water per day. 6 references. (auth)

60202 DEVELOPMENT OF EXPERIMENTAL MULTI-PURPOSE HIGH TEMPERATURE GAS-COOLED REACTOR. Nozawa, Shunya; Nozawa, Masao (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 13: No. 8, 468-74(Aug 1971). (In Japanese).

Design studies as well as research and development on different aspects of an experimental multi-purpose high temperature reactor were initiated at the Japan Atomic Energy Research Institute (JAERI) at the end of 1969. The outlet temperature of the reactor is supposed to be 1,000°C and the power 50 MW(t). A brief description is given of two design studies undertaken in JAERI. Items of research and development related to the reactor are discussed. Also a summary is presented of views of the Japanese Atomic Energy Commission on the multi-purpose utilization of nuclear heat from high temperature reactors, and of the activities of the Iron and Steel Institute of Japan on the use of nuclear heat for steel making. (auth)

Marine and Portable Power Reactors

60203 (AD-721019) THEORETICAL NUCLEAR ANALYSIS OF THE MH-1A: CORES 2 AND 3. Final Report. Gregory, Michael V.; Iyer, Shrinivas S.; Lillie, Richard A.; Henry, C. Daniel (Army Engineer Reactors Group, Fort Belvoir, Va. Engineering Div.). 1 Mar 1971. 110p. (ED-7102). NTIS.

The methods and results of the theoretical analysis of the nuclear properties of MH-1A Cores 2 and 3 are presented. The basic physical parameters are obtained by use of two cross-section codes, LEOPARD and LEOPROD, an X-Y geometry depletion code TURBO*, plus a Z-axial calculation using the CNCR-2 code together with the HOMOG and PEAK processor codes. The theory, results, and input details of the LEOPROD blackness theory code giving absorber region constants are considered in some detail. (auth) (USGRDR)

60204 KONSTRUKTIVNYE OSOBENNOSTI ATOMNYKH SUDOV. (Constructional Features of Nuclear-Powered Vessels). Volkov, N. N.; Kodatskii, S. B. Leningrad; Izdatel'stvo Sudostroenie (1971). 248p.

The special features of construction of atomic-powered transport vessels are presented. Provision for radiation safety on shipboard during collisions, running aground on sandbanks, or other damage is discussed, with details of shielding construction surrounding the reactor compartment. Experimental studies are an important aspect of the subject, and attenuation is focussed on model building and testing. Materials of construction are evaluated for shielding purposes. The probability of uncontrolled release of radioactivity on shipboard is considered. 91 references. (K.S.W.)

60205 NUCLEAR-POWERED SHIP MUTSU. Higuchi, Niroku (Ishikawajima-Harima Heavy Industries Co. Ltd., Tokyo). Kuki Chowa To Reito; 10: No. 11, 149-56(Oct 1970). (In Japanese).

The first nuclear-powered ship "Mutsu" is complete except for the installation of a nuclear reactor. The features of the ship are: the thermal output of the reactor, 36 MW; main-engine power, 10,000 ps; navigational speed, 16.5 kt; and the number of crew, 79. The air conditioning of the ship, involving the countermeasure against radioactivity is described. It is divided into those for radiation control areas, residential areas, and operation-control rooms. The radiation control area includes a reactor and auxiliary facilities, and the rooms for sampling, measurement, waste storage and contamination survey. The air in the area is handled collectively in 2 systems. It is passed through filters, diluted with the air from blowers, then via ducts, finally discharged to the atmosphere. For the residential area, two systems of air conditioning are used separately for upper and lower decks; but when one of them fails, the single system is capable of serving both decks. The air conditioning for the operation-control rooms is mainly for the protection of instruments, and also for the crew. (Japan)

60206 NUCLEAR POWER OPERATIONS DEEP FREEZE 70-71. Bell, Myron H. (Naval Nuclear Power Unit, Fort Belvoir, Va.). Antarctic J. U. S.; 6: No. 4, 144-5(Jul-Aug 1971).

The PM-3A nuclear power plant operation and maintenance during 1970 and early 1971 are summarized. (H.D.R.)

60207 NUCLEAR POWERED SHIPS AND MARINE REACTORS. Part 2-4 of Kaernkraftdrift av Fartyg. Goteborg; Stiftelsen foer Skeppsbyggnadsteknisk Forskning ([1971]). (In Swedish).

General information such as journal articles and commercial news items about nuclear ships and ship reactors is given along with data for specific ships and reactors. It consists of about 500 loose sheets which are revised and supplemented continuously. (Sweden)

Production Reactors

60208 SYSTEMS APPROACH TO NUCLEAR PLANT PROTECTIVE SYSTEMS DATA PROGRAM. Crosetti, P. A.; Faught, M. L. (Douglas United Nuclear, Inc.; Richland, Wash.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 317-22(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A computerized data program for the Hanford nuclear reactor complex is described. This program is used for the recording, checking, handling, and utilization of large amounts of test and inspection data on nuclear plant protective systems. The program features data collection at the system level, yet it readily permits data collection at the equipment, component, or failure mode level as needed. 3 references. (auth)

Reactor Theory

60209 (DUN-7538) WIGL2, A SELF-INITIALIZING VERSION. Agee, L. J. (Douglas United Nuclear, Inc., Richland, Wash.). 5 Feb 1971. Contract AT(45-1)-1857. 120p. Dep. NTIS.

The original version of WIGL2 is a one-dimensional, two-group, space-time diffusion theory program with zero, one, or six delayed neutron groups. The program will treat slab, cylindrical, and spherical geometries, and it includes nonboiling heat transfer. Xenon feedback and feedback effects due to fuel and coolant temperature are accounted for. Control rod motion and control system feedback based on total core power or outlet coolant temperature can be simulated. Transients may be excited by prescribed changes in inlet coolant temperature, coolant flow rate, or rod position. One of the major difficulties involved in using WIGL2 was that it required a balanced set of initial conditions. If the program input does not meet this requirement, WIGL2 will appear to have experienced a perturbation, the size of which is of the order of the accuracy of the input, and the variables of interest (fluxes, temperature, etc.) will begin to change with time, i.e., experience a drift. The problem of the drift has been eliminated by using the program HFN as an input subroutine. HFN does a critical search adjusting one of the few-group parameters so the reactor is "just critical" and returns the flux shape. The flux shape is used (with the heat transfer parameters) to determine the fuel and coolant temperature in each of the thermal hydraulic regions. The flux shape is also used to determine the xenon, iodine, and precursor distribution. To make the program more usable with Hanford-type reactors, a second rod bank was added which will trip when a scram signal is generated. The output was also modified to give the user more control over the amount of output printed. (auth)

60210 (JAERI-Memo-4406) BENCHMARK TEST BY VARIOUS CROSS SECTION SETS FOR FAST REACTOR ANALYSIS IN JAPAN. Ishiguro, Y.; Takano, H.; Hasegawa, A.; Katsuragi, S.; Iijima, S. (Japan Atomic Energy Research Inst., Tokyo). Apr 1971. 20p. (In Japanese and English). Dep. NTIS (U. S. Sales Only).

The results obtained by the benchmark test working group of the Reactor Constants Subcommittee in the Japanese Nuclear Data Committee are presented. The object of this working group was to analyze the standard critical assemblies using various cross section sets and codes for fast reactor analysis in Japan, to wash out various problems from the results, and to utilize the information obtained for aiming at future revision of the cross section sets. (auth) (Japan)

60211 (RPI-328-189) FORMULATION AND APPLICATION OF ANALYTIC REPRESENTATIONS OF FAST REACTOR FLUX AND IMPORTANCE SPECTRA. Dunn, Floyd E.; Becker, Martin (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Science). [nd]. Contract AT(30-3)-328. 79p. Dep. NTIS.

A model is developed for the study of fast reactor flux and importance spectra. The model is based on slowing down theories of the continuous slowing down type with suitable modifications introduced where such theories are deficient. The ability to obtain analytic solution for the flux and importance spectra depends on the ability to fit basic cross section ratios (such as the moderating ratio) to simple analytic forms. The cross section fits are used to obtain an expression for the slowing down density, which generally is a smooth function. Detailed cross sections, however, are used to relate flux and importance to slowing down density. The model yields good agreement with multigroup spectra on both broad group and ultra-fine group bases and yields quite accurate values for integral parameters (e.g., criticality and reaction rates). In addition, it is found to be possible to get a good correlation of cross section fit parameters with composition. 10 references. (auth)

60212 STATIC AND PULSED REACTIVITY MEASUREMENTS ON LARGE ^{235}U FUEL FORMS IN WATER. Currie, R. L.; Parks, P. B.; Jarriel, J. L. (Savannah River Lab., Aiken, S. C.). Nucl. Technol.; 12: No. 4, 356-62(Dec 1971).

Subcritical multiplication constants were derived from static and pulsed measurements for arrays of large, hollow cylinders of uranium-aluminum alloy. The cylinders were of two types: 11.21-cm-ID, 20.07-cm-OD bare ^{235}U-Al alloy castings and 10.07-cm-ID, 12.27-cm-OD Al-clad "logs" extruded from the castings. The alloy was 9.985 weight percent enriched uranium (92.2% ^{235}U) in aluminum. These measurements extended previous benchmark experiments with small diameter rods of lower enrichment into the region of larger diameters and higher enrichments. The transport diffusion theory codes MGBS-TGAN overestimated the values of k_{eff} for the arrays tested by 7 to 12%. The more sophisticated Monte Carlo code KENO was more accurate, with errors less than 5%. 17 references. (auth)

60213 APPLICATION OF MODERN CONTROL THEORY TO SPATIALLY DEPENDENT NUCLEAR REACTORS. Tsai, Tsung-yuan. Blacksburg, Va.; Virginia Polytechnic Inst. (1971) 130p. University Microfilms Order No. 71-21,067.

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Thesis.

A study of control problems in large nuclear reactors is presented. The problem of designing feedback controllers to track and regulate reactor power optimally is formulated as an optimal control problem. The state space method of modern control theory is used. Within the framework of this new concept, the analysis and the design of an optimal controller are precisely defined. Particular attention is focused on the problem of controlling spatial power distributions. The mathematical model includes a one-energy-group, space-dependent diffusion equation, a one-group delayed neutron equation, dynamics for xenon and iodine concentrations, typical equations for thermal feedback loops, and simple second-order dynamics for a control rod positioning mechanism. The choice of this model is based on the assumption that the model adequately describes the physical process and yet is simple enough for the purpose of controller implementation. The design of the controller is divided into two portions. The first considers the power tracking problem and the second considers the steady-state regulating problem. With this division, a lower-order model is used by neglecting the time constants that are irrelevant to the transient responses. The optimal control theory is applied to the nonlinear power tracking problem. This results in a set of canonic partial differential equations with split boundary conditions. A finite difference method is used to obtain the numerical solution. Solving the two-point boundary-value problem is the most difficult task in this optimal controller design. To transform the modern techniques to practical designs, several fixed-structural schemes are considered. During the regulating phase, the linearized equations about an operating point are used. Linear control theory is applied to derive an optimal feedback controller. Examples are presented to demonstrate the feasibility of this scheme. (Diss. Abstr. Int., B)

60214 SYNTHESIS SOLUTIONS OF THE MULTIGROUP BOLTZMANN EQUATION FOR SLABS. Schwetje, W. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Sci. Eng.; 46: No. 1, 159-65(Oct 1971).

Some special half-range expansions in known expansion functions and unknown coefficient functions for solving the multigroup Boltzmann equation for slabs are described. The expansion functions, to be chosen by the user, can take into account nearly all information that may be available over the space-, angle-, and energy-dependence of the expected solution. Transport boundary conditions can be exactly satisfied, which is of importance in small, absorbing or only weakly multiplying systems. Two of the expansions eliminate one variable, the other two expansions eliminate two variables. The resultant reduced equations for the coefficient functions are rather simple and can be solved numerically. The expansions are applied to calculations of the neutron distribution within a thin homogeneous natural uranium slab. (auth)

60215 SYNTHESIS OF FAST REACTOR NEUTRON ENERGY SPECTRA. Ombrellaro, P. A.; Snider, M. A. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 46: No. 1, 150-9(Oct 1971).

Synthesis models are used to obtain 50 energy-group synthesized flux and current spectra for several fast reactor compositions. These spectra are compared with 50 energy-group exact spectra for the same compositions. (auth)

60216 INVESTIGATIONS OF FUEL CONSUMPTION IN REACTOR OPERATION WITH VARYING DURATION OF THE CAMPAIGNS. Meyer, K. (Ingenieurhochschule, Zittau, Ger.). Kernenergie; 14: No. 5, 144-7(May 1971). (In German).

Using a simple model with alternating campaigns of shorter and longer duration, the fuel consumption as referred to the energy released is shown to be equal to that in periodic operational regime with a duration of campaigns corresponding to the arithmetic mean of campaigns of shorter and longer duration, provided that the reactivity at the end of the two campaigns is equal to that at the end of campaigns in periodic regime. (auth)

60217 OPTIMIZATION STUDY OF FAST REACTORS. Kuz'min, A. M.; Silaev, Yu. V.; Orlov, V. V.; Khromov, V. V. At. Energ. (USSR); 31: No. 2, 83-8(Aug 1971). (In Russian).

Methods for the optimization of fast reactor design parameters are examined. Problems of uniform power distribution and minimization of the plutonium fuel requirements are considered. Results of a reactor power optimization analysis are presented and discussed. 10 references. (auth)

60218 REAL TIME REACTOR SIMULATION ON A HYBRID COMPUTER. Doi, Kazuyori; Sano, Kenji (Atomic Energy Research Lab., Hitachi, Japan). Nippon Genshiryoku Gakkaishi; 13: No. 8, 447-52(Aug 1971). (In Japanese).

A feasibility study was made on a hybrid computer for real time simulation to be used in large systems. Both the Boiling Water Power Reactor (BWR) and the Sodium Cooled Experimental Fast Reactor (EFR) were simulated, which, when relying on pure analog simulation, requires several nonlinear elements and about 100 operational amplifiers. In the hybrid simulation, the analog part undertakes the operations of linear transfer functions, while the digital parts take care of function generation as well as the multiplication and division of the arithmetic operations. Two problems of transients were considered, i.e., insertions of reactivity in the form of a ramp of 2.16 cents/sec in the operation of the BWR, and that of a step of 10 cents in the EFR. It was found that the error due to the digital execution time was negligible, which attested to the validity of the above-mentioned appropriation of functions to the analog and digital parts. The study proves that real time simulation can more easily and accurately be realized with a hybrid than with an analog computer. 14 references. (auth)

60219 PARAMETER SENSITIVITY OF THE REACTOR CONTROL SYSTEM BY MEANS OF THE ROOT LOCUS METHOD. Park, Je Baik; Yook, Chong Chul; Park, In Yong. Hanyang Univ. Res. Works Grad. Sch.; 5: 206-13(1969).

Root locus is a plot of the roots of the characteristic equation of the closed-loop system as a function of the gain. The root locus analysis to determine the gain sensitivity of a control system is standard procedure, i.e., an analytical procedure for obtaining the root locus with positive gain is described and it has been well developed. The stability and dynamics of the reactor control system are analyzed by means of the root locus method about variation of the over-all gain of transfer function. By a simple extension, root locus procedure will also yield information on the effect of variations in such additional parameters of the reactor control system as the time constant of the first order term for the damping coefficient of the second order term for the range from the negative infinite to the positive infinite. (Korean Sci. Abstr.)

60220 MINIMUM CRITICAL MASS OF ^{235}U REFLECTED BY NATURAL URANIUM IN WATER. Gray, A. W. (Westinghouse Electric Corp., Pittsburgh). Nucl. Technol.; 12: No. 4, 342-7 (Dec 1971).

An analytical study was completed to define minimum critical mass parameters for a spherical region containing a ^{235}U-H_2O mixture reflected by a natural U-H_2O mixture. The study indicates that for an optimum natural-H_2O reflector, the calculated minimum critical mass for the central sphere lies in the range of 75 to 200 grams of ^{235}U. The analytic study was divided into three phases. In the first phase homogeneous, two-region systems were examined using diffusion theory programs. The results indicated a minimum critical mass of 451 grams ^{235}U for an optimal system. In the second phase a Monte Carlo program was utilized to compute K_{eff} for U metal rod-H_2O moderated lattices for which experimental data are available. The purpose of the second phase was to establish the validity of the Monte Carlo program as an analytical tool. In the third phase the Monte Carlo program was used to calculate ^{235}U + H_2O spheres closely reflected by an optimum lattice of natural U rods. The Monte Carlo program indicates that the minimum critical mass in an H_2O moderated system reflected by a U metal lattice is 135 ± 65 grams ^{235}U 11 references. (auth)

60221 EVOLUTION OPERATOR METHOD AND ITS APPLICATION TO PROBLEMS OF REACTOR THEORY. Abedin-Zadeh, R.; Pucker, N. (Univ., Graz). Acta Phys. Austr.; 32: No. 1, 47-59(1970).

The "evolution operator method" is an approximation procedure and is derived from the time-dependent perturbation theory of quantum mechanics, where also the name "evolution method" is used. This procedure allows the approximate calculation of functions which depend on the canonical quantities q(x) and p(x) of a given problem. More generally one is able to calculate the same functions of the corresponding disturbed problem, if the solution of the undisturbed case is known. For applications in reactor physics, the flux $\phi(x)$ is used instead of q(x). The meaning of the generalized variable p(x) follows from the specific problem under consideration. The foundations of the method are outlined very shortly. One is able to show in this way very easily that the method of Lie-series coincides with the evolution operator method. With the help of a simple example from diffusion theory, the advantages and disadvantages of the method are demonstrated. 15 references. (auth)

60222 NUCLEAR HEAT TRANSPORT. El-Wakil, M. M. Scranton, Pa.; International Textbook Company (1971). 512p. $16.50.

The processes of heat generation and transport in nuclear reactor cores and the thermal design of reactor cores are investigated. Basic reactor physics aspects are reviewed to develop the neutron flux distributions and reaction rates in a core. The effects of heat generation and temperature distributions in fuel elements and core components in the steady and unsteady states are examined. The mechanisms of heat removal by single-phase and two-phase nonmetallic and metallic coolants are discussed. Hydrodynamics and thermal design procedures for boiling and non-boiling cores are outlined. 156 references. (H.D.R.)

Kinetics

Refer also to abstract 60005.

60223 (AD-721076) ANALYTICAL PULSE REACTOR MODEL WITH DELAYED NEUTRONS. Leonard, B. E. (Armed Forces Radiobiology Research Inst., Bethesda, Md.). Dec 1968. 71p. (AFRRI-SR-68-25). NTIS.

The Fuchs–Nordheim model is extended to develop an approximate solution to the point reactor equations of motion which includes delayed neutrons and nonadiabatic systems. Self-limiting reactor excursions are considered. Time-dependent relations for both reactor power and energy generated are obtained. The division of the time domain allows a superposition of the prompt burst and delayed neutron tail powers. The initial delayed neutron tail power is shown to be nearly independent of pulse size. Experimental measurements of TRIGA pulses from 1.00 × beta to 3.21 × beta show only a few percent deviation from theory for the prompt burst and delayed tail powers for pulses above 1.10 × beta. A 16 percent deviation is found for a 1.00 × beta pulse. The theoretical results are provided, with tables and figures, in such a form as to be easily applied to problems requiring self-limiting reactor excursion analysis. (auth) (USGRDR)

60224 (EURFNR-899) STRATEGIES FOR ACCELERATING TWO-DIMENSIONAL SN METHODS BY COARSE LATTICE TECHNIQUE. Kinnebrock, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK-1361. 14p. Dep. NTIS.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The time of two dimensional SN-calculations can be shortened if the initial flux is prepared by a SN-calculation with less spatial points. Also this initial calculation can be shortened in time in the same way. A statistical interpretation is presented of 120 transport-problems calculated by the two dimensional SN-code "SNØW" with different strategies. Simultaneously there is developed a theory, describing the calculation-time in dependence of the applied strategy. This theory made it possible to find strategies which save about 60% calculation-time in the mean. 11 references. (auth)

60225 (JAERI-Memo-4394) CALCULATION CODE FOR THERMAL NEUTRON MULTI-GROUP REACTOR CONSTANTS: THERMOS-MUG. Ise, Takeji; Horikami, Kunihiko (Japan Atomic Energy Research Inst., Tokyo). Apr 1971. 42p. (In Japanese and English). Dep. NTIS (U. S. Sales Only).

A computer code has been prepared for calculating thermal neutron multi-group reactor constants. The code is a modified version of the ANL-THERMOS code. The modifications are made on the following points: a program for obtaining the multi-group constants for thermal neutrons is added; any scattering kernel can be fed into this code with input cards of BCD form with the present outputs from GAKER-MUG, UNCLE-TH, and FLANGE treated by this code; and the maximum number of velocity meshes is increased up to 60. 9 references. (auth) (Japan)

60226 (LFEN-NI.-60-a) FORTRAN PROGRAM LFEN-FR 10: DETERMINATION OF THE DIFFUSION LENGTH OF THERMAL NEUTRONS IN MODERATOR FROM EXPERIMENTAL DISTRIBUTIONS OF THE NEUTRON FLUX. Martinho, E. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1970. 13p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

The CODINETE 25 program makes it possible to determine the diffusion length of thermal neutron in the moderator from an experimental distribution of the neutron flux. The 25 most significant harmonic modes are considered in the program. The theory of the CODINETE 25 is given and the sequence of calculation is outlined. The characteristics of the program are presented. The data input and the readout are described. (J.S.R.)

60227 BEHAVIOR OF THE INTEGRAL REACTOR CHARACTERISTIC K^+. Mogil'ner, A. I. At. Energ. (USSR): 30: No. 4, 389-90(Apr 1971). (In Russian).

The integral reactor characteristic has been defined as K^+ = average number of generated neutrons/average losses due to internal processes, whereby "internal processes" designate absorption, moderation, scattering and fission. It is attempted to clarify the physical meaning of the dependence of K^+ on the chosen mathematical model and to determine the connection of K^+ and K_∞, the neutron multiplication factor in an infinite medium. An expression was derived indicating that K^+ is a characteristic of the core material; it is only slightly affected by the dimensions of the reactor and the composition of the reflector. In cases when the two-group approximation is applicable, K^+ is larger than K_∞. (TTT)

60228 NEUTRON FLUX IN CELLS OF FINITE, SQUARE LATTICES. Auerbach, T. (Eidgenoessische Technische Hochschule, Zurich). Nucl. Sci. Eng.; 46: No. 1, 61-75(Oct 1971).

The multigroup neutron flux in cells of finite, regular, unreflected, square lattices is determined. The dependence on buckling and on cell squareness is shown explicitly for the moderator spectrum only. The corresponding fuel spectrum at each lattice site may be obtained readily from the condition of flux continuity. Heterogeneous theory of the source-sink type forms the starting point of the theory. It is shown that each integration constant appearing in the heterogeneous solution for a finite periodic lattice separates into a product of two constants, one of which is a purely geometrical factor of position x_i, y_i of the i'th element, while the other is a purely physical constant depending on the physical characteristics of the lattice alone. Knowledge of the position dependence allows the flux in a square cell of a finite system to be determined for all multipole orders by means of summation techniques. The physical constants are obtained from multipole moderator-to-fuel boundary conditions. These conditions are expressed in terms of response coefficients and result in a set of equations from which the position dependence is again eliminated by means of summation techniques. The result is a set of simultaneous equations for the physical constants alone which can be solved once the criticality condition is satisfied. The number of these equations is independent of the number of elements in the lattice and equals twice the number of multipoles times the number of energy groups. (33 references) (auth)

60229 METHOD FOR DETERMINING THE COEFFICIENTS OF REACTOR TRANSFER FUNCTIONS. Pridatko, S. A.; Trofimov, A. S. This paper was summarized in At. Energ. (USSR); 29: No. 5, 362(Nov 1970) as paper No. 437/5477. (In Russian).

One of the problems in the investigation of nuclear reactor control is the determination of the dynamic characteristics, which may vary during operation. The structure of the characteristics (the transfer functions), obtained from a consideration of the physical processes taking place, remains constant for a given reactor, but the dynamic coefficients are subject to variation. Determining these coefficients on a reactor in actual operation is an important theoretical and practical problem. The general experimental methods for determining the dynamic characteristics of controlled devices (transfer functions, amplitude-phase characteristics) are based, as a rule, on an analysis of the way in which the device reacts to a typical test signal or to natural disturbances present in the form of noise. The transfer functions studied usually have the form of rational fractions. In the present study the method of "areas" for determining the coefficients of the transfer function of a stable linear system for a stepwise disturbance at the input is extended to the case of arbitrary input disturbances. In addition, the transfer function is assumed to be transcendental; this means that the device can be described by partial differential equations. 4 references. (auth)

60230 COLLISION PROBABILITY CALCULATIONS OF MULTIPLICATION FACTORS FOR LATTICES. Hunt, Douglas C. (Dow Chemical Co., Golden, Colo.). J. Franklin Inst.; 291: No. 6, 417-26(Jun 1971). (RFP-1186).

A multigroup version of the method of successive generations is used to determine the multiplication factors of unmoderated and unreflected periodic lattices of identical fissile components. The lattice components must be one-dimensional (i.e., spheres, infinitely long cylinders or infinite slabs). Lattices of nearly one-dimensional components (cubes or long cylinders) may, however, be approximately treated. The lattice components may be arranged in a linear, planar or cuboidal manner; the permissible component arrangements being limited by the lattice component geometry. The computation traces successive neutron collisions in the lattice, starting from a uniform neutron-source density distribution in each lattice component. The initial source-density energy distribution is specified in a 16-group format which is obtained from S_4 transport equation solutions. The method satisfactorily predicts the critical pitch of two experimentally measured lattices and, to this degree of confidence, is used to compute the critical parameters of other similar lattices. The method is also used to find the reactivity temperature coefficient of thermal expansion for several just-critical arrays. This coef-

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ficient is found to be positive for large arrays of small elements which have a high interaction factor. 15 references. (auth)

60231 NEW APPROXIMATION IN THE CALCULATION OF COLLISION PROBABILITIES IN CLUSTER-TYPE FUEL LATTICES. Yamamoto, Kazuko; Ishida, Masayoshi (Hitachi Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 8: No. 8, 458-64(Aug 1971).

A new approximation is proposed for calculating the first flight collision probabilities in cluster-type fuel lattices, based on the subcell model. In this method the unit cluster is divided into subregions of fuel pins (with or without cladding) arranged in rings, associated coolant, and homogeneous annular regions surrounding the fuel region. The fuel pins and associated coolant are treated separately, and each is distinguished ringwise as a different subregion. The collision probability is then calculated for a neutron proceeding from one subregion to another. The method treats rigorously the fuel annulus where a neutron starts with consideration given to the non-uniform structure of the annulus. The other fuel annuli, however, are treated approximately as if each annulus was homogeneous. The values of the homogenized cross sections of the annuli are determined in such manner that the number of outgoing neutrons from the homogenized annuli equals that from the actual non-uniform fuel annuli. The collision probability is then apportioned among fuel pins and coolant in the annulus. The results of the method compare favorably with those of the exact methods based on direct numerical evaluation of the collision probabilities. Multigroup application of the method shows that the time require for calculation is comparable with the standard multigroup calculation scheme. 10 references. (auth)

60232 EFFECT OF ACCELERATOR PULSE SHAPES ON NEUTRON SLOWING DOWN TIMES. Beynon, T. D.; Mondal, M. A. W. (Univ. of Birmingham, Eng.). J. Nucl. Energy; 25: No. 9, 391-5(Sep 1971).

A technique using a Green's function is used to obtain general expressions for the effect of a finite pulse width on the average and most probable slowing down time of a neutron field in a moderator. The method allows corrections for the width of the pulse to be made either to measurements or calculations. (auth) (UK)

60233 SOLUTION OF THE MULTI-DIMENSIONAL, MULTI-GROUP DIFFUSION EQUATION USING THE LIE SERIES METHOD BARE REACTOR. Lemanska, M. (Soreq Nuclear Research Centre, Yavne, Israel). J. Nucl. Energy; 25: No. 9, 397-403 (Sep 1971).

The multi-dimensional G-group diffusion equation is solved using the technique of the generalized Lie series with operators of higher order. The variables are separated in the solution obtained. Critical equations are derived. A method for calculating the critical size of multi-dimensional bare reactor is given. It is shown that this method is simpler than the usual diffusion method. (auth) (UK)

60234 ESTIMATION OF REACTOR PARAMETERS BY OPTIMAL FILTERING METHOD. Suda, Nobuhide; Shirai, Shoji (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 8, 438-43 (Aug 1971).

Measurements of reactor parameters, such as prompt neutron generation time and subcriticality, have been made using band pass filters or else applying the correlation technique. Other new methods of reactor parameter estimation would now appear to be available thanks to developments in the optimal filtering technique, such as the optimal linear (Kalman) filter and some of the nonlinear optimal filters. Such new methods should prove very promising for on-line estimation of the reactor parameters. A description is given of the application of some of these new methods to subcriticality measurements. The results of computer simulation of estimates using the Kalman filter are presented, as also an account of experiments with the actual reactor noise obtained on the Toshiba Training Reactor (TTR-1), using a nonlinear analog filter. The results agree with those reported by Nomura using conventional methods. 10 references. (auth)

60235 IMPROVEMENT TO THE CALCULATION OF COLLISION PROBABILITIES IN ANNULAR SYSTEM AND ITS APPLICATION TO CLUSTER GEOMETRY. Takeda, Toshikazu; Sekiya, Tamotsu (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 9, 503-12(Sep 1971).

A new method of calculating first-flight collision probabilities in cluster geometry is developed. The collision probabilities in an annular system as well as the transition probabilities for a neutron escaping from one subcell to reach other subcells are calculated and combined. The former is an improvement on Bonalumi's approximation and the latter is an extension of the Dancoff correction to subcells containing fuel rods and coolant. As applications of the present method, the collision probabilities in a hexagonal cluster with 7 fuel rods and in a square cluster with 28 fuel rods are calculated. Fairly good agreement is obtained by comparing the probabilities with the results obtained by the exact method. One-group calculations of the flux distribution are carried out in these systems. 15 references. (auth)

60236 NONLINEAR DYNAMIC OPTIMIZATION TECHNIQUE FOR CONTROLLING XENON INDUCED OSCILLATIONS IN LARGE NUCLEAR REACTORS. Love, Carl G. (Westinghouse Research Labs., Pittsburgh). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 408-11(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

The problem of controlling the spatial power distribution in a reactor core under changing load conditions is formulated as a nonlinear optimization problem. The one-dimensional distributed core model is approximated by using finite differences to obtain a set of nonlinear ordinary differential equations. Linear programming is then used in an iterative scheme to determine the optimum control rod strategy. 3 references. (auth)

60237 MILTIGROUP, SPATIALLY DEPENDENT STUDIES OF MILD EXCURSIONS IN LARGE FAST REACTORS. Picarelli, John Gerard. Urbana, Ill.; Univ. of Illinois (1971). 163p. University Microfilms Order No. 71-21,211.

Thesis.

A method is developed for the analysis of mild excursions in large fast reactors. Studies of mild excursions, that is, transients which may be expected to occur during the normal operation of a large fast reactor, are performed for two representative, sodium-cooled assemblies. The method is based on a perturbation approximation to the one-dimensional, space- and time-dependent, multigroup diffusion equations. No temperature feedback effects are included. In the perturbation approximation, the group scalar fluxes, the delayed neutron precursor concentrations, and the nuclear parameters defining the reactor assembly are written in terms of their steady state values plus time-dependent changes or perturbations. The spatial dependence of the fluxes and the precursor concentrations is represented by series of even and odd Jacobi polynomials, which are orthogonal over the interval [−1, 1]. The governing system of coupled, partial differential equations is reduced to systems of first-order, ordinary differential equations. The coefficients defined in the even and odd polynomial expansions are taken to be time-dependent functions and are determined as solutions to these systems of first-order equations. The systems of first-order equations belong to the class of stiff differential equations. Conventional Taylor series and multistep methods, when applied to such equations, are restricted to very small time steps to guarantee stability. A technique developed by Gear, however, permits efficient and accurate solutions of stiff equations. This technique is applied to the systems of first-order, ordinary differential equations. Results are obtained in two- and six-group studies of transients arising from sodium void and ^{239}Pu perturbations. These results show that the method predicts proper behavior based on elementary neutron physics considerations as applied to large fast reactors. (Diss. Abstr. Int., B)

60238 ANALYTICAL AND EXPERIMENTAL INVESTIGATION OF THE NEUTRON ENERGY EFFECTS ON REACTOR FLUCTUATION SPECTRA. Ackermann, Norbert Joseph Jr. Knoxville, Tenn.; Univ. of Tennessee (1971). 136p. University Microfilms Order No. 71-21,864.

Thesis.

An analytical and experimental investigation of the neutron energy effects on reactor fluctuation spectra was performed to provide some information about the nonpoint model dependence of reactor noise. A two-energy group, one space point reactor kinetics model was developed using the Langevin conjecture. This model predicted no deviation from the one-energy group, point kinetics model in the frequency range of experimental interest except that the cross power spectral density (CPSD) between the two-energy groups was a complex valued function and that the thermal neutron lifetime could be determined directly from the slope of the curve for the tangent of the phase angle of that CPSD. A reactor noise experiment was performed to investigate these effects using an incore detector that was detecting thermal neutrons in the reactor core and an out-of-core detector that was detecting core fast leakage neutrons in the water shield. The auto power spectral density (APSD) of the incore and out-of-core detectors and the CPSD between the two gave results which were in agreement within the experimental uncertainties. However, the tangent of the CPSD phase angle did not give a slope which agreed with the thermal lifetime of the reactor. (Diss. Abstr. Int., B)

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Dynamics

Refer also to abstract 60171.

60239 LYAPUNOV STABILITY OF SPATIALLY-DEPENDENT NONLINEAR REACTOR SYSTEM INCLUDING AN EXTERNAL PRIMARY HEAT EXCHANGER. Hsu, C.; Habegger, L. (Argonne National Lab., Ill.). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 412-17(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

In the study of reactor system stability, the past work is mainly concentrated in two areas: the study of reactor core stability using either the point model or distributed model, and the study of plant dynamics using a lumped parameter model with time delay. The former study assumed no interaction between the core dynamics and the rest of the components in the system whereas the latter neglected the distributed effect, thus some salient features in the system may be lost. The stability of a distributed reactor system which consists of the core dynamics with nonlinear temperature feedbacks, the external primary heat exchanger, and the coolant loop interconnecting these two major components is analyzed. The coupled set of nonlinear partial differential equations is treated directly without recourse to the usual lumped parameter approximation. An extension of Lyapunov's theory, which has been successfully used in the study of distributed core dynamics, is employed to obtain stability criteria for this coupled system. 3 references. (auth)

60240 ANALYSIS OF SPACE-DEPENDENT DYNAMIC PROPERTIES OF POWER REACTORS. Yoshikawa, Hidekazu; Wakabayashi, Jiro (Kyoto Univ., Uji, Japan). Nippon Genshiryoku Gakkai Rochuseishi Kenkyu Senmon Iinkai Hokoku; No. 31, 1-22 (Nov 1970). (In Japanese).

Dynamic analyses of nuclear, thermal and hydrodynamical properties of large scale power reactors were carried out. The dynamic nuclear property can be solved approximately with a diffusion model for small number of groups. A finite cylindrical reactor with plural regions in Z direction of flow was assumed. Quasi-static approximation was employed, in which asymptotic neutron flux at each time-mesh and asymptotic reverse reactor frequency were obtained approximately by a modified Helmholtz expansion method. Analysis was carried out thermally and hydrodynamically on a representative single flow path. Heat conduction along Z axis was neglected in consideration of heat transfer in fuel rods. Melting at center of the fuel rods was also ignored. Temperature dependence of heat conductivity, specific heat and density of fuel material was disregarded, and an equation of heat conductivity in radius vector direction was analyzed by difference approximation. Dynamic properties of single phase and two phase flow are described by conservation laws of mass, momentum and energy, but analysis was carried out by difference approximation on the basis of momentum integration method. A model that reactor constants in each region of each group vary with variation of fuel temperature, coolant temperature and amount of bubbles was used in calculation of internal feed back effects. The method described can show slow transient phenomena as the primary approximation of behavior in nuclear, thermal and hydrodynamical properties after production of voids. (Japan)

60241 OPTIMAL POWER CHANGE OF A REACTOR HAVING INTERNAL FEEDBACK. Akimoto, Tadashi; Ogawa, Yuichi (Hokkaido Univ., Sapporo). Nippon Genshiryoku Gakkaishi; 13: No. 9, 500-7(Sep 1971). (In Japanese).

State space-constrained time optimal control having internal feedback can be obtained by two alternative modes of control. One is that which brings the system from the initial equilibrium state to the objective equilibrium state in minimum time, and the other raises the reactor power to the objective level with maximum rapidity in order to follow the load change immediately. In the former mode, the controllability of the nonlinear system is rigorously satisfied if the delayed neutrons are ignored, and even with the delayed neutrons taken into account the system can be optimally controlled for practical purposes. In the latter mode, a system of control must be provided to apply after the objective power level is reached, in order to bring the reactor system to the final equilibrium state while keeping the power level constant. The choice between the two modes of control would depend on the purpose of reactor operation. (9 references) (auth)

Experimental Applications

60242 MEASUREMENT OF TEMPERATURE FLUCTUATIONS IN A NATURAL CONVECTION WATER LOOP. Nishihara, Hideaki (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo); 8: No. 8, 450-7(Aug 1971).

Investigations of reactor noise in water-cooled research reactors show that the power spectra density rises in the low frequency domain. The cause of this phenomenon is often attributed to fluctuations in the coolant temperature, but this has never been proved experimentally. An attempt in this direction was undertaken. The temperature fluctuation in a natural convection heat transfer loop decoupled from neutronics was measured and analyzed in the frequency domain. The test section of the loop had a rectangular channel measuring 5 mm × 50 mm in cross section and 500 mm in length. This configuration simulated a coolant channel of the MTR-type fuel element used in swimming-pool reactors. The power spectral density of the temperature fluctuation at the channel exit showed a shape similar to the power spectral density of the noise-equivalent source obtained in the Kyoto University Reactor at comparable power levels. 13 references. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 57609, 57614, 57624, 57632, 57633, 57639, 57645, 57647, 57666, 57724, 57780, 57876, 58163, 58166–58168, 58185, 58194, 58216, 58294, 58344, 58347, 58355, 58410, and 58411.

60243 MELTING HEAT RATING OF UO_2–25 WT. PERCENT PuO_2 FUELS. Lawrence, L. A.; Christensen, J. A. (Hanford Engineering Development Lab., Richland, Wash.). Nucl. Technol.; 12: No. 4, 367-74(Dec 1971).

For UO_2– 25 wt % PuO_2, the quantity $\int_{T_s}^{T_m} kdT$ was established at 49 ± 5 W/cm, where $T_s = 700°C$, k is the fuel thermal conductivity, and T_s and T_m refer to fuel surface and melt temperatures, respectively. This result derives from measurements on six individual fuel pins. Each pin was surrounded by a calorimeter consisting of a heavy-walled aluminum sleeve with thermocouples at two radial positions. Heat generation rates measured calorimetrically were supplemented by postirradiation burnup analyses for ^{140}Ba, ^{141}Ce, and ^{95}Zr. Fuel pins were irradiated for ten hours at steady-state, peak heat ratings after which they were rapidly quenched to preserve structures representative of peak power operation. Fractional fuel melting was correlated with heat rating and the correlation extrapolated to zero melting to yield melting heat rating. Flux depression corrections are required to apply these measurements, which were made in a thermal flux, to fast flux environments. These were obtained by measuring radial burnup profiles in several irradiated cross sections and numerically integrating the results. 12 references. (auth)

60244 NUCLEAR REACTOR CONTROL DEVICE. Frisch, Erling; Andrews, Harry N.; Braun, Howard E. (to Westinghouse Electric Corp.). U. S. Patent 3,595,748. 27 Jul 1971. Filed 24 Jan 1968.

A nuclear reactor is disclosed wherein a portion of its fuel assemblies have primary or shutdown neutron absorbing control elements coupled to incremental drive mechanisms, and a portion of its fuel assemblies have one or more individually movable auxiliary fine flux trim rods (FFT) coupled to new and improved two-position mechanisms. The two-position mechanisms are associated with curved guide channels in such a manner as to control the position of individual FFT rods associated with a plurality of fuel assemblies. (Official Gazette)

60245 MEASUREMENT TRANSMITTER. (to Belgonucleaire SA). British Patent 1,241,139. 28 Jul 1971. Priority date 12 Jul 1968, Belgium.

REACTORS—core measurements in, device for magnetic transmission of

TELEMETERING SYSTEM—design parameters for magnetic (H.D.R.)

60246 NUCLEAR FUEL RETAINER. Smith, Bart Alan; Lass, James Lloyd (to General Electric Co.). British Patent 1,240,617. 28 Jul 1971. Priority date 23 Sep 1968, United States.

REACTOR FUEL ELEMENTS—design with cup-shaped retainer between fuel and fission gas plenum (H.D.R.)

60247 NUCLEAR REACTOR FUEL ASSEMBLY. Crowther, Russell Lee (to General Electric Co.). British Patent 1,241,456 4 Aug 1971. Priority date 15 Dec 1967, United States.

REACTOR FUEL ELEMENTS—design of assemblies with radially varying plutonium and uranium contents (H.D.R.)

60248 DESIGN OF SPECIFICALLY OPTIMAL FILTERS FOR NUCLEAR REACTOR SYSTEMS. Schweizer, Philipp F. (Westinghouse Electric Corp., Pittsburgh). IEEE (Inst. Elec. Electron. Eng.), Trans. Nucl. Sci.; NS-18: No. 1, 403-7(Feb 1971).

From IEEE nuclear science symposium; New York, N. Y. (4 Nov 1970).

A design procedure is presented for selecting the optimal parameters of a filter used in extracting true signals from noisy reactor measurements. The equations for the optimal filter are presented and a procedure is given for approximating the optimal filter with a simpler and less expensive structure. A design example demonstrates how the method may be applied to a reactor protective system. 4 references. (auth)

60249 PERSPECTIVES OF PLUTONIUM UTILIZATION SEEN FROM 1970. Lafontaine, I. (Belgo-Nucleaire SA, Brussels). J. Belge Radiol.; 54: No. 1, 111-18(Jan-Feb 1971). (In French).

Uranium production is estimated for the western world. Data for the years 1971 through 1985 are presented as tables and diagrams. Installations, both in operation and in the planning stage, for the recycling of plutonium are listed and discussed. Also listed are facilities for the production of plutonium fuel elements. It is concluded that, in the coming decade, cost for plutonium fuel production must be reduced so that plutonium and enriched uranium become competitive. In comparison with ^{235}U, plutonium has advantages for fast breeder reactors. (H.B.G.)

60250 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Gatley, John Andrew; Jackson, George Oliver (to United Kingdom Atomic Energy Authority). British Patent 1,246,275. 15 Sep 1971. Filed 20 Dec 1967.

Reference is made to fuel elements of the tubular fuel pin type, having internal and external sheaths, with fuel material in the annular space between the two sheaths, thus allowing better cooling, particularly with ceramic fuels. A disadvantage is that allowance must be made for differential expansion between the sheaths. The fuel pin described is designed to allow for such expansion. The outer and inner sheaths are sealingly secured together at one end of the fuel pin, while the other ends are sealed together by a bellows seal so as to permit relative longitudinal movement. A second bellows seal is provided, spaced from the first seal, and a venting duct to the outside of the fuel pin is located between the two seals. This duct may be wrapped helically around the outer sheath to act as a spacer for the pins and promote mixing of the coolant flowing over the pins. The helically wound tube also allows for decay of short-lived fission products. (UK)

60251 FUEL ASSEMBLY WITH SOLID END-FITTING. Gumuchian, A. (to Commissariat a l'Energie Atomique). Canadian Patent 877,595. 3 Aug 1971. Priority date 6 Jun 1967, France.

The end fitting of a fuel assembly is constituted by a solid cylinder which is intended to be placed within a stationary cylindrical support tube of a nuclear reactor diagrid. The support tube is provided with openings for the admission of a cooling fluid such as liquid metal. The lower extremity of the end fitting has a recess for the engagement of a member which locks the end fitting in the support tube. The upper extremity of the end fitting is attached to a connecting element which is joined to the fuel assembly box containing the fuel pins. The connecting element is pierced by openings so that the cooling fluid, which is admitted into the space formed between the support tube and the end fitting, can circulate between the space and the interior of the fuel assembly box. (F.S.A.)

60252 NUCLEAR FUELLING ARRANGEMENT. McConkey, K. N. (to Canadian General Electric Co. Ltd.). Canadian Patent 877,592. 3 Aug 1971.

The structure of a fuel bundle and end fittings for the channels in a pressure tube nuclear reactor are described. Latches are employed to retain the fuel bundles within the reactor pressure tube against the force of coolant flow. Each bundle is provided with contracting end pads which permits the insertion or retraction of a bundle while unloading the latch from axial forces exerted thereagainst, so that jamming may be avoided and complete latch disengagement assured. (F.S.A.) (Canada)

60253 CORE ASSEMBLY FOR NUCLEAR REACTORS. Gumuchian, A. (to Commissariat a l'Energie Atomique). Canadian Patent 878,198. 10 Aug 1971. Priority date 5 Dec 1966, France.

A fuel assembly for nuclear reactors is described which consists of clusters of pins disposed within a tubular sleeve. This consists of a duct for the circulation of coolant and which is constituted by a thin metallic strip wrapped in a helix around the clusters and in close contact therewith. Each turn of the strip is rigidly joined to the adjacent turns. The end turns are respectively fixed to a bottom end-fitting and to a solid top end-fitting of the assembly. (F.S.A.) (Canada)

60254 CENTERING DEVICE FOR NUCLEAR REACTOR LOADING MACHINES. Kumpf, H. (to Siemens Aktiengesellschaft). Canadian Patent 873,597. 15 Jun 1971.

The device consists of a movable vertical tubular loading mast and a clamping mechanism, for grasping the fuel elements, in the mast interior. The mast includes a tubular member located at and telescoping the lower end and displaceable in the longitudinal direction. The arrangement is thus able to select a particular fuel element from the lattice forming the reactor core. The tubular member has a lower edge portion formed with a surface to engage the fuel elements of the reactor core located adjacent to the selected fuel element so as to align the latter with the mast. (F.S.A.) (Canada)

60255 FUEL SYSTEMS FOR NUCLEAR REACTORS. Nims, John B. Jr. (to Atomic Power Development Associates Inc.). U. S. Patent 3,600,276. 17 Aug 1971. Filed 12 May 1967.

A nuclear reactor is described comprising an array of fuel subassemblies having tapered cooperating interface surfaces, whereby longitudinal expansion of the sub-assembly causes radial core expansion. (auth)

60256 SAFETY ARRANGEMENTS FOR PRESSURE VESSELS. (to Siemens Aktiengesellschaft). British Patent 1,247,148. 22 Sep 1971. Priority date 9 Jul 1969, Germany.

REACTOR CONTAINMENT STRUCTURES—design characteristics of prestressed concrete (D.C.C.)

60257 SERIES PAIRS OF DOOR SETS. Martlew, Clifford Keith (to United Kingdom Atomic Energy Authority). British Patent 1,243,979. 25 Aug 1971. Filed 16 Nov 1967.

Reference is made to door sets primarily for use in nuclear reactor air locks. The series pair of door sets described comprises, for each door set, a manually operable fastening and an electrically controlled fastening. A switch mechanism, operable by the mechanism of the manual fastening, is arranged for actuating the electric fastening of the opposing door set. The switch mechanisms and fastenings are so arranged that one door set is unfastened at the electrically controlled fastening only when the other door set is fastened by its manually operable fastening. The arrangement may be applied to double leaf door sets. (UK)

60258 NUCLEAR REACTOR PRESSURE VESSELS. (to Siemens Aktiengesellschaft). British Patent 1,247,897. 29 Sep 1971. Priority date 29 Dec 1967, Germany.

PRESSURE VESSELS—design of reactor, with prestressed concrete walls and steel cover

REACTORS—pressure vessels for, use of steel cover on prestressed concrete (H.D.R.)

60259 HANDLING GRIP. Naudet, Robert; Renaux, Charley (to Commissariat a l'Energie Atomique). French Patent 2,039,528. 4 Jan 1971. Filed 2 Apr 1969. (In French).

A device for gripping control rods in a fast neutron reactor cooled by liquid metal is described. It consists of a body revolving about a vertical axis upon which two fingers pivot about a pin perpendicular to this axis. (France)

GENERAL

60260 (AECL-3783(Rev.1)) PACKAGE OF COMPUTER PROGRAMS FOR THE ANALYSIS OF TEMPERATURE DISTRIBUTION IN THREE DIMENSIONAL SYSTEMS. Carver, M. B. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Jul 1971. 38p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

60261 (BNL-50299) MEMBRANES, MATERIAL TRANSFER, AND IDEAL TRACER THEORY. Nims, Leslie F. (Brookhaven National Lab., Upton, N. Y.). Jun 1971. 8p. Dep. NTIS.

60262 (BNWL-SA-3977(Rev.)) ECOLOGICAL AND ENVIRONMENTAL PROBLEMS IN THE APPLICATION OF BIOMATHEMATICS. Vaughan, Burton E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1971]. 29p. (CONF-710716-1). Dep. NTIS.

From sixth symposium on mathematical statistics and probability; Berkeley, Calif. (19 Jul 1971).

60263 (BRH/DMRE-71-5) NUCEAR MEDICAL TECHNOLOGY TRAINING. Proceedings of a Colloquium held on February 28, 1969 at the Radioisotope Laboratory, Cincinnati General Hospital, Cincinnati, Ohio. Simmons, Guy H. (ed.) (Cincinnati Univ., Ohio. Medical Center. Bureau of Radiological Health, Rockville, Md. Div. of Medical Radiation Exposure). Jun 1971. 71p. GPO $0.75.

60264 (CALT-767-P-3-15) MEASUREMENT OF DISLOCATION DAMPING FORCES AT HIGH DISLOCATION VELOCITY. Jassby, K. M.; Vreeland, T. Jr. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). [1971]. 17p. Dep. NTIS.

60265 (CALT-767-P-3-16) DISLOCATION MOBILITY IN COPPER AND ZINC AT 44°K. Jassby, K. M.; Vreeland, T. Jr. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). [1970]. 7p. Dep. NTIS.

60266 (CALT-767-P-3-17) EXPERIMENTAL DETERMINATION OF THE LINE ENERGY OF A BASAL SCREW DISLOCATION IN ZINC. Nagata, N.; Jassby, K. M.; Vreeland, T. Jr. (California Inst. of Tech., Pasadena. W. M. Keck Lab. [of Engineering Materials]). [1971]. 20p. Dep. NTIS.

60267 (CALT-767-P-3-18) BASAL DISLOCATION INTERACTIONS WITH A FOREST OF NON BASAL DISLOCATIONS IN ZINC. Nagata, N.; Vreeland, T. Jr. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). 1971. 26p. Dep. NTIS.

60268 (CONF-711014-1) ANALYSIS OF REPAIR IN HUMAN DNA BY 5-BROMODEOXYURIDINE PHOTOLYSIS. Regan, James D. (Oak Ridge National Lab., Tenn.). [1971]. 14p. Dep. NTIS.

From Symposium on DNA repair mechanisms; Erbach, Germany (3 Oct 1971).

60269 (COO-1826-17) BIOLOGY OF CARCINOMA IN SITU OF THE LUNG. [Saccomanno, Geno] ([Saint Mary's Hospital, Grand Junction, Colo.]). [nd]. 3p. (CONF-710631-1). Dep. NTIS.

From American Institute of Biological Sciences meeting; Washington, D. C. (9 Jun 1971).

60270 (COO-2094-7) ICR QUARTERLY REPORT NO. 29, MAY 1, 1971. Ashenhurst, Robert L. (Chicago Univ., Ill. Inst. for Computer Research). Contract AT(11-1)-2094. 94p. Dep. NTIS.

60271 (COO-2094-8) ICR QUARTERLY REPORT NO. 30, AUGUST 1, 1971. Ashenhurst, Robert L. (Chicago Univ., Ill. Inst. for Computer Research). Contract AT(11-1)-2094. 136p. Dep. NTIS.

60272 (DASA-2711) EFFECTS OF AIRBLAST ON SHEEP IN TWO-MAN FOXHOLES. Richmond, D. R.; Fletcher, E. R.; Jones, R. K. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). 1 Jun 1971. Contract DASA-68-C-0118. 38p. (POR-LN-401).

60273 (LA-4421) DIVIDING HEAD TABULATIONS. Briscoe, W. L.; Gibson, T. O. (Los Alamos Scientific Lab., N. Mex.). 16 Mar 1970. 19p. Dep. NTIS.

60274 (LA-4744) BOUNDS ON THE BANDWIDTH OF BIPARTITE GRAPHS. Korfhage, Robert R. (Los Alamos Scientific Lab., N. Mex.). Sep 1971. Contract W-7405-eng-36. 5p. Dep. NTIS.

60275 (MHSMB-24) STATIC DETECTOR. Technical Report No. 201. Hanna, H. A. (Mason and Hanger-Silas Mason Co., Inc., Burlington, Iowa). 6 Jan 1971. Contract W-49-010-AMC-68(A). 24p. Dep. NTIS.

60276 (NP-19036) NINETEENTH ANNUAL REPORT FOR THE YEAR ENDED 30 JUNE 1971. (Australian Atomic Energy Commission). 147p. Dep. NTIS (U. S. Sales Only).

Activities for the year ending 30 June are described. Summaries are given of the status of the Jervis Bay nuclear power station; uranium exploration activities in Australia; radioisotope development, production and distribution; research related to nuclear power and associated disciplines; and international matters. Nuclear power is also discussed in a more general sense with respect to management and regulation, the environment, and world wide developments. Publications by staff are listed. (Australia)

60277 (NYO-3515-5) TRANSPORT AND CATABOLISM OF PROTEINS, TECHNIQUES AND MECHANISMS. Final Report, March 1965–February 1970. Hughes, Walter L. (Tufts Univ., Boston, Mass. Dept. of Physiology). Contract AT(30-1)-3515. 15p. Dep. NTIS.

60278 (NYO-3515-6) UPTAKE OF ^{125}I LABELED RAT GAMMA GLOBULIN BY INTESTINAL EPITHELIAL CELLS IN THE NEONATAL RAT. King, Paul N.; Hughes, Walter L. (Tufts Univ., Boston, Mass. Dept. of Physiology). Sep 1970. Contract AT(30-1)-3515. 11p. Dep. NTIS.

60279 (NYO-3798-12) MOESSBAUER SPECTROSCOPY OF BIOCHEMICALS CONTAINING IRON. Progress Report No. 6, October 1, 1970–August 31, 1971. May, Leopold (Catholic Univ. of America, Washington, D. C. Dept. of Chemistry). Sep 1971. Contract AT(30-1)-3798. 10p. Dep. NTIS.

60280 (ORNL-TM-3549) PROBABILISTIC MODEL FOR ESTIMATING THE OPERATING COST OF AN ELECTRIC POWER GENERATING SYSTEM. Joy, D. S.; Jenkins, R. T. (Oak Ridge National Lab., Tenn.). Oct 1971. Contract W-7405-eng-26. 42p. Dep. NTIS.

60281 (ORO-3344-4) FORMATION ENERGIES OF INDIVIDUAL VACANCIES IN ALKALI HALIDES. Final Report. Plint, C. A. (Oklahoma Univ. Research Inst., Norman). 10 Mar 1971. Contract AT(40-1)-3344. 42p. Dep. NTIS.

60282 (ORO-3885-3) CELL RESPONSE TO NUCLEIC ACID PENETRATION. Progress Report, September 1970–August 1971. Stuy, Johan H. (Florida State Univ., Tallahassee). Contract AT(40-1)-3885. 11p. Dep. NTIS.

60283 (RLO-2225-T-10-3) AQUATIC MYXOBACTERIA, CHONDROCOCCUS COLUMNARIS AND OTHER FISH PATHOGENS. Progress Report, 1971. Ordal, Erling J. (Washington Univ., Seattle. Dept. of Microbiology). Contract AT(45-1)-2225. 27p. Dep. NTIS.

60284 (RLO-2225-T-15-7) CHARACTERIZATION AND FRACTIONATION OF TOBACCO LEAF TRANSFER RNA. Guderian, Ronald H.; Pulliam, Robert Lee; Gordon, Milton P. (Washington Univ., Seattle. Dept. of Microbiology). 1970. 35p. Dep. NTIS.

60285 (RLO-2226-T-3-8) DETECTION OF ANTINUCLEAR ANTIBODIES IN NZB AND OTHER MOUSE STRAINS. Siegel, B. V.; Brown, McKay; Morton, Jane I. (Oregon Univ., Portland. Medical School). [1971]. 19p. Dep. NTIS.

60286 (SC-DR-710418) DEVELOPMENT OF AN ELECTRIC MANOMETER TESTER. Hayes, Everett G. (Sandia Labs., Albuquerque, N. Mex.). Oct 1971. 12p. Dep. NTIS.

60287 (SC-M-710408) PROGRAM FGCD (USER'S AND PROGRAMMER'S MANUAL). Toliver, Lee (Sandia Labs., Albuquerque, N. Mex.). Apr 1971. 29p. Dep. NTIS.

60288 (SC-RR-710502) EYE-CONTROLLED VERSUS HAND-CONTROLLED TRACKING. Bechtel, F. K.; Langenhorst, J. W.

XUM

(Sandia Labs., Albuquerque, N. Mex.). May 1971. 62p. Dep. NTIS.

60289 (SC-RR-710628) OPERATIONAL AMPLIFIER MODELS FOR COMPUTER-AIDED CIRCUIT ANALYSIS. Harstad, David N. (Sandia Labs., Albuquerque, N. Mex.). Oct 1971. 40p. Dep. NTIS.

60290 (UCLA-12-839) FATTY ACID TRANSPORT INTO THE BRAIN. Dhopeshwarkar, G. A.; Subramanian, Carole; McConnell, Douglas H.; Mead, James F. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). 1971. Contract AT-04-1-GEN-12. 18p. Dep. NTIS.

60291 (UCRL-20525) HETEROGENEOUS DISLOCATIONS IN GaAs. Osiecki, R.; Thomas, G. (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1971. Contract W-7405-eng-48. 7p. (CONF-710439-1). Dep. NTIS.
From second international conference on high-voltage electron microscopy; Stockholm, Sweden (14 Apr 1971).

60292 (UCRL-20700) DISLOCATION CONTRAST AT HIGH VOLTAGES. Osiecki, R.; De Jonghe, L. C.; Bell, W. L.; Thomas, G. (California Univ., Berkeley. Lawrence Radiation Lab.). Jun 1971. Contract W-7405-eng-48. 8p. (CONF-710439-2). Dep. NTIS.
From second international conference on high-voltage electron microscopy; Stockholm, Sweden (14 Apr 1971).

60293 (UCRL-72001) MODES OF COMPUTER AUTOMATION IN THE CHEMISTRY LABORATORY. Frazer, Jack W. (California Univ., Livermore. Lawrence Radiation Lab.). 16 Jul 1971. 23p. (CONF-700303-2). Dep. NTIS.
From twenty-first conference on analytical chemistry and applied spectroscopy; Cleveland, Ohio (1 Mar 1970).

60294 (UCRL-73197) MICROWAVE ROTATIONAL SPECTROSCOPY APPLIED TO TRACE-GAS POLLUTANT MONITORING. Hrubesh, Lawrence W. (California Univ., Livermore. Lawrence Radiation Lab.). 3 Aug 1971. 8p. (CONF-711102-1). Dep. NTIS.
From Joint conference on measurement of environmental pollutants; Palo Alto, Calif. (8 Nov 1971).

60295 (UCRL-Trans-10548) PREPARATION AND CONTROL OF THE FUNCTIONING OF A MERCURY CATHODE CELL WORKING AT AN IMPOSED POTENTIAL. Moinet, Claude; Peltier, Daniel. Translated for Univ. of California, Lawrence Radiation Lab., Livermore, from Bull. Soc. Chim. Fr.; No. 2, 690-6(1969). 19p. Dep. NTIS.

60296 MIRNOE ISPOL'ZOVANIE ATOMNOI ENERGII. MEZHDUNARODNOPRAVOVYE VOPROSY. (World Use of Atomic Energy. Questions of International Law). Malinin, S. A. Moscow; Izdatel'stvo Mezhdunarodnye Otnosheniya (1971). 176p.

Questions of international law represent the focal point of this presentation of the various aspects of the world-wide use of atomic energy. Forms of collaboration of governments, legal problems connected with nuclear powered ships, and radioactive waste disposal are some of the chief topics covered. (268 references) (K.S.W.)

CORPORATE AUTHOR INDEX

In the Corporate Author Index, technical report literature is indexed by the organization or institution responsible for issuing the report. Entries are given for all report literature and for published literature for which a corporate author approach is especially desirable, e.g., symposium and conference proceedings.

Each entry under a corporate author gives the publication title and the *NSA* volume and abstract numbers. Report numbers, where applicable, are given in parentheses at the end of the entry.

A

- AEROJET-GENERAL CORP., AZUSA, CALIF.
  - Ball bearing design for SNAP-8 turboalternator and mercury pump, 25:57617 (N-71-26910)
  - Thermal design of SNAP 8 tantalum stainless steel boiler, 25:60194 (N-71-27855)
- AEROJET NUCLEAR CO., IDAHO FALLS, IDAHO.
  - Summary of ETR Critical Facility safety analysis information, 25:60149 (ANCR-1002)
- AKADEMIYA NAUK SSSR, MOSCOW. INSTITUT FIZIKI.
  - Investigation of the laser initiated discharge spark channel, 25:59076 (UCRL-Trans-10556)
- AKADEMIYA NAUK SSSR, MOSCOW. INSTITUT ZEMNOGO MAGNETIZMA, IONOSFERY I RASPROSTRANENIYA RADIOVOLN.
  - Solar wind parameter variation, magnetic activity, and electrons of the tail of magnetosphere and radiation zone, 25:58852 (LA-tr-71-69)
- AKADEMIYA NAUK UKRAINSKOI SSR, KHARKOV. FIZIKO-TEKHNICHESKII INSTITUT.
  - Characteristics of collisionless damping of electromagnetic wave in a region of intense inhomogeneity of a cold plasma, 25:59081 (AEC-tr-7272)
  - Plasma density measurement by means of an open resonator, 25:58977 (AEC-tr-7271)
- AKTIEBOLAGET ATOMENERGI, STUDSVIK (SWEDEN).
  - Integral measurement of fission-product reactivity worths in some fast reactor spectra, 25:60034 (AE-428)
- ALABAMA POWER CO., BIRMINGHAM.
  - Joseph M. Farley Nuclear Plant, Units 1 and 2. Preliminary safety analysis report, Amendment 23, 25:59988 (DOCKET-50348-27)
- ALLIED-GULF NUCLEAR SERVICES, BARNWELL, S.C.
  - Barnwell Nuclear Fuel Plant. Reasons why the construction permit should not be suspended pending supplemental environmental review, 25:57516 (DOCKET-50332-20)
- AMES LAB., IOWA.
  - Capillary-reservoir diffusion studies in Hg--In alloys utilizing continuous resistivity measurement of composition, 25:58210 (IS-T-490)
- ARGONNE NATIONAL LAB., ILL.
  - Chemical Engineering Division fuel cycle technology quarterly report, January--March 1971, 25:57507 (ANL-7799)
  - Chemical Engineering Division. Cross sections and burnup semiannual report, January--June 1971, 25:60035 (ANL-7824)
  - Development of a mixer-settler for liquid metal-salt systems, 25:57508 (ANL-7810)
  - Experimental irradiations of fuel elements having known cladding defects in EBR-II, 25:60082 (ANL-7782)
  - Feasibility study of the identification of fuel-cladding failures using sodium-soluble isotopic tags, 25:60083 (ANL-7785)
  - Manufacture of clad fissionable foils for ZPR measurements, 25:58180 (CONF-711002-, pp 70-6)
  - Preparation of nuclear research materials with a laboratory-type isotope separator, 25:57649 (CONF-711002-, pp 1-9)
  - Prog. rpt. on physical chemistry of liquid metals and molten salts, semiannual, 1--6/71, 25:58387 (ANL-7823)
  - Prog. rpt. on reactor development, 8/71, 25:60005 (ANL-7854)
  - Prog. rpt. on sodium technology, 1--3/71, 25:60058 (ANL-7817)
- ARKANSAS POWER AND LIGHT CO., LITTLE ROCK.
  - Arkansas Nuclear One, Unit 2. Preliminary safety analysis report, Amendment 13, 25:59994 (DOCKET-50368-17)
- ARMED FORCES RADIOBIOLOGY RESEARCH INST., BETHESDA, MD.
  - Analytical pulse reactor model with delayed neutrons, 25:60223 (AD-721076)
- ARMY ENGINEER REACTORS GROUP, FORT BELVOIR, VA. ENGINEERING DIV.
  - Theoretical nuclear analysis of MH-1A: Cores 2 and 3, 25:60203 (AD-721019)
- ATLANTIC RICHFIELD HANFORD CO., RICHLAND, WASH.
  - Control of a continuous ion exchange system, 25:57510 (ARH-SA-82)
  - Macroreticular ion exchange resin cleanup of Purex process TBP solvent, 25:57509 (ARH-SA-58)
  - Radiolysis of citric acid solution, 25:57457 (ARH-2163)
- ATOMIC ENERGY OF CANADA LTD., CHALK RIVER (ONTARIO).
  - Research materials in Atomic Energy of Canada Limited, 25:58209 (AECL-3992)
- ATOMIC ENERGY OF CANADA LTD., CHALK RIVER (ONTARIO). CHALK RIVER NUCLEAR LABS.
  - Diffusion coefficient as a guide to prospects for high-temperature zirconium alloys, 25:58208 (AECL-3967)
  - Gamma monitor for measuring environmental gamma doses and dose rates, 25:57721 (AECL-3989)
  - Package of computer programs for the analysis of temperature distribution in three dimensional systems, 25:60260 (AECL-3783(Rev.1))
  - Plutonium production in NPD: comparison between experiment and calculation, 25:60093 (AECL-3995)
  - Plutonium recycle in CANDU-type PHW heavy water reactors, 25:60092 (AECL-3910)
  - Special techniques in target preparation, 25:59639 (CONF-711002-, pp 134-43)
  - TOFA: a CDC 6600 computer code for torsional frequency analysis, 25:60057 (AECL-3994)
- ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL (ENGLAND).
  - Preparation of stable and active nuclide targets, 25:59635 (CONF-711002-, pp 91-100)
- ATOMIC WEAPONS RESEARCH ESTABLISHMENT, ALDERMASTON (ENGLAND).
  - Evaluation of average ν for ^{238}U, 25:59775 (AWRE-O-44/71)
  - Preferential deposition of thin silver films induced by electron bombardment, 25:58178 (AWRE-O-42/71)
- ATOMICS INTERNATIONAL, CANOGA PARK, CALIF.
  - Analysis of aerosol behavior for FFTF hypothetical accidents, 25:60148 (AI-69-Memo-95)
  - Preparation of tungsten-modified mixed carbide, 25:58365 (AI-AEC-12983)
  - Prog. rpt. on fuels, materials, and coolant chemistry programs, annual, 1969, 25:58163 (AI-AEC-12859)
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B

- BABCOCK AND WILCOX CO., LYNCHBURG, VA. POWER GENERATION DIV.
  - Reactor vessel material surveillance program, 25:58294 (BAW-10006(Rev.2))
- BALTIMORE GAS AND ELECTRIC CO., MD.
  - Calvert Cliffs Nuclear Power Plant, Units 1 and 2. Final safety analysis report, Amendment 14, Revision 3, 25:59975 (DOCKET-50317-29)
  - Calvert Cliffs Nuclear Power Plant, Units 1 and 2. Statement why construction permits should not be suspended pending completion of NEPA environmental review, 25:59974 (DOCKET-50317-28)
- BATTELLE MEMORIAL INST., COLUMBUS, OHIO.
  - Prog. rpt. on applicability of data to the description of reactor accident, 4--6/71, 25:60111 (BMI-1917)
- BATTELLE-NORTHWEST, RICHLAND, WASH. PACIFIC NORTHWEST LAB.
  - Ecological and environmental problems in the application of biomathematics, 25:60262 (BNWL-SA-3977(Rev.))
- BATTELLE PACIFIC NORTHWEST LABS., RICHLAND, WASH.
  - Destruction of nitrous acid and hydrazoic acid in purex systems, 25:57511 (BNWL-B-121)

XUM

Natural cesium in sea water, 25:57301 (TID-25776)
Neutron spectra from (α,n) reactions in plutonium compounds calculated from Hauser--Feshbach reaction theory, 25:59708 (BNWL-B-109)
Summary report on analysis of semi-fluid condition in PG-6 phosphate glass solids container, 25:57702 (BNWL-B-112)
Thin film radiation sources by radiofrequency sputtering, 25:57651 (CONF-711002-, pp 147-59)
BHABHA ATOMIC RESEARCH CENTRE, BOMBAY (INDIA).
Progress of seismology in India, 25:57591 (INIS-mf-71, pp 181-98)
BLUME (JOHN A.) AND ASSOCIATES RESEARCH DIV., SAN FRANCISCO, CALIF.
Approximate procedure for determining building dynamic response characteristics, 25:57592 (JAB-99-70)
BORG-WARNER (CANADA) LTD., TORONTO (ONTARIO). BYRON JACKSON DIV.
Canadian centrifugal pump industry, 25:57608 (70-CNA-658)
BOSTON EDISON CO., MASS.
Pilgrim Nuclear Power Station. Preoperational environmental radiation survey program. Quarterly report, April 1--June 30, 1971, 25:59966 (DOCKET-50293-56)
BRITISH NUCLEAR ENERGY SOCIETY, LONDON (ENGLAND).
Conference on voids formed by irradiation of reactor materials, Reading, Eng., 3/71, 25:58304
BROOKHAVEN NATIONAL LAB., UPTON, N. Y.
Experimental work in the Brookhaven Chemonuclear In-Pile Research Loop, 25:57610 (BNL-50293)
Membranes, material transfer, and ideal tracer theory, 25:60261 (BNL-50299)
BROWN BOVERI/KRUPP REAKTORBAU G.M.B.H., MANNHEIM (WEST GERMANY).
Release of gaseous fission products from carbons, 25:58367 (EUR-4327)
BUREAU OF RADIOLOGICAL HEALTH, ROCKVILLE, MD. DIV. OF MEDICAL RADIATION EXPOSURE.
Colloquium on nuclear medical technology training, Cincinnati, Ohio, 2/69, 25:60263 (BRH/DMRE-71-5)
State and Federal control of health hazards from radioactive materials, 25:58028 (BRH/DMRE-71-4)

C

CALIFORNIA INST. OF TECH., PASADENA. W. M. KECK LAB. OF ENGINEERING MATERIALS.
Basal dislocation interactions with a forest of non basal dislocations in zinc, 25:60267 (CALT-767-P-3-18)
Dislocation mobility in copper and zinc at 44°K, 25:60265 (CALT-767-P-3-16)
Experimental determination of the line energy of a basal screw dislocation in zinc, 25:60266 (CALT-767-P-3-17)
Measurement of dislocation damping forces at high dislocation velocity, 25:60264 (CALT-767-P-3-15)
Observation of slip bands in molybdenum single crystals by x-ray diffraction, 25:58271 (CALT-767-P-3-19)
Occurrence of superconductivity in simple cubic (Au/sub 1-x/Pd/sub x/)Te$_2$ alloys, 25:58928 (CALT-822-37)
CALIFORNIA UNIV., BERKELEY. LAWRENCE BERKELEY LAB.
Heavy-ion-induced single- and double-strand breaks in PHIX-174 replicative form DNA, 25:57952 (LBL-28)
In vivo radiobiological studies of 910 MeV helium ion beam, 25:57997 (LBL-314)
CALIFORNIA UNIV., BERKELEY. LAWRENCE RADIATION LAB.
Containment in Tokamak and bumpy torus, 25:58961 (CONF-711016-1)
Dislocation contrast at high voltages, 25:60292 (UCRL-20700)
Heterogeneous dislocations in GaAs, 25:60291 (UCRL-20525)
CALIFORNIA UNIV., LIVERMORE. LAWRENCE LIVERMORE LAB.
Nuclear-explosion seismology, 25:57593 (TID-25572)
CALIFORNIA UNIV., LIVERMORE. LAWRENCE RADIATION LAB.
Calculation of surface and ground waves from above-ground and underground explosions, 25:57594 (UCRL-73369)
Evaluated nuclear cross section library, 25:59783 (UCRL-50400(Vol.4))
Liquid chromatography. I, 25:57526 (UCRL-73190(Rev.1))
Microwave rotational spectroscopy applied to trace-gas pollutant monitoring, 25:60294 (UCRL-73197)
Modes of computer automation in the chemistry laboratory, 25:60293 (UCRL-72001)
Nuclear chimneys: underground containers for chemical and metallurgical processing, 25:57604 (UCRL-73130)
Plea for consistent lung burden criteria for insoluble alpha emitting isotopes, 25:58001 (UCRL-73388)
Threshold photoneutrons and photon doorways, 25:59784 (UCRL-73336)
CALIFORNIA UNIV., LOS ANGELES.
Comparative myocardial uptake and clearance characteristics of potassium and cesium, 25:58041 (UCLA-12-837)
CALIFORNIA UNIV., LOS ANGELES. DEPT. OF PHYSICS.
Reaction (p,^{3}He) mechanisms in light nuclei, 25:59711 (UCLA-10-P-18-32)
CALIFORNIA UNIV., LOS ANGELES. LAB. OF NUCLEAR MEDICINE AND RADIATION BIOLOGY.
Fatty acid transport into the brain, 25:60290 (UCLA-12-839)
CALIFORNIA UNIV., LOS ANGELES. SCHOOL OF MEDICINE.
Comparison of radioaerosol versus radioxenon inhalation procedures in obstructive lung disease and pulmonary embolism, 25:58040 (UCLA-12-834)
CARNEGIE-MELLON UNIV., PITTSBURGH, PA.
Cross sections for (π^+,p) reactions on ^{9}Be, ^{12}C, and ^{16}O, 25:59710 (LA-DC-12781)
Dispersion relations for nuclear structure physics, 25:59691 (LA-DC-12958)
New measurements of $(\pi^+,2p)$ reactions on light nuclei, 25:59709 (LA-DC-12389)
CAROLINA POWER AND LIGHT CO., RALEIGH, N.C.
H. B. Robinson Unit No. 2. Brunswick Steam Electric Plant Units 1 and 2. Statement why construction permits should not be suspended pending completion of NEPA environmental review, 25:59951 (DOCKET-50261-74)
CATHOLIC UNIV. OF AMERICA, WASHINGTON, D. C. DEPT. OF CHEMISTRY.
Prog. rpt. on Moessbauer spectroscopy of biochemicals containing Fe, annual, 10/70--8/71, 25:60279 (NYO-3798-12)
CENTRAL ELECTRICITY GENERATING BOARD, BERKELEY (ENGLAND). BERKELEY NUCLEAR LABS.
Biological aspects of skin irradiation. III, 25:58000 (RD/B/R-1934)
Method for producing thin foils from graphitic materials for transmission electron microscopy, 25:58350 (RD/B/N-2020)
Nucleation of atomic steps on inert gas bubbles intersected by dislocations, 25:58214 (RD/B/N-2023)
Observations on particulates in a sodium loop, 25:58170 (RD/B/N-1998)
On the limitations of the method of least squares for the treatment of certain types of data, 25:58301 (RD/B/N-1971)
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE, MOL (BELGIUM).
GBR fuel pin technology, 25:58410 (BLG-456)
CESKOSLOVENSKA AKADEMIE VED, REZ. USTAV JADERNEHO VYZKUMU.
Partition chromatography of uranium and fission products on porous styrene-divinylbenzene copolymer swollen in the solution of tributylphosphate. III, 25:57527 (UJV-2557-Ch)
CHICAGO UNIV., ILL. INST. FOR COMPUTER RESEARCH.
Prog. rpt., 5/71, 25:60270 (COO-2094-7)
Prog. rpt., 8/71, 25:60271 (COO-2094-8)
CINCINNATI UNIV., OHIO. MEDICAL CENTER.
Colloquium on nuclear medical technology training, Cincinnati, Ohio, 2/69, 25:60263 (BRH/DMRE-71-5)
COLORADO STATE UNIV., FORT COLLINS. DEPT. OF ATMOSPHERIC SCIENCE.
Prog. rpt. on radioactive fallout and disturbances in mid-latitude westerlies, 7/71, 25:57572 (COO-1340-24)
COLUMBIA UNIV., NEW YORK.
ISIS: program for computerized fission data analysis, 25:59773 (AD-721481)
COLUMBIA UNIV., NEW YORK. DEPT. OF CHEMISTRY.
Role of angular momentum and isobaric spin in tests of the independence hypothesis, 25:59830 (CU-1019-82)
COMITATO NAZIONALE PER L'ENERGIA NUCLEARE, FRASCATI (ITALY). LABORATORI NAZIONALI DI FRASCATI.
Observations on production of hadrons by means of Landau--Lifshitz process, 25:59334 (LNF-71/14)
COMITATO NAZIONALE PER L'ENERGIA NUCLEARE, ROME (ITALY).
Activity and infrastructure of CNEN for the reuse of plutonium for nuclear fuel, 25:58351 (RT/ING-(70)30)
Heavy water production, industrial processes, and plants, 25:57652 (DAISE-70-8)
Radiotoxicological analyses used at CNEN, 25:57347 (RT/PROT-(71)9)
SASSI: FORTRAN program for calculation of neutron scattering from a spherical optical potential, 25:59842 (RT/FI-(71)6)
COMMISSARIAT A L'ENERGIE ATOMIQUE, BRUYERES-LE-CHATEL (FRANCE). CENTRE D'ETUDES.
Development of ^{242}Cm--Be and ^{238}Pu--Be neutron sources, 25:59669 (CEA-R-4172)
Mechanism of reactions (d,p) and (d,t) induced by low energy (120 to 200 keV) deuterons on ^{9}Be. Determination of characteristics of excited levels of ^{11}B obtained by reactions ^{9}Be + d, 25:59827 (CEA-R-4070)
COMMISSARIAT A L'ENERGIE ATOMIQUE, FONTENAY-AUX-ROSES (FRANCE). CENTRE D'ETUDES NUCLEAIRES.
Deformation of the electron distribution function under the influence of a large amplitude wave, 25:59012 (CEA-CONF-1833)
Dissipative instability associated with electrons trapped in tokamak-type configurations, 25:59060 (CEA-CONF-1800)
Electron correlations in unified line shapes, 25:59026 (CEA-CONF-1834)
Electrostatic instabilities in a two-component anisotropic plasma, 25:59061 (CEA-CONF-1828)
Linear conversion of waves for an oblique incidence, 25:59082 (CEA-CONF-1803)
Nonlinear harmonic generation in a thermal magnetized plasma, 25:59013 (CEA-CONF-1835)

XUM

- COMMISSARIAT A L'ENERGIE ATOMIQUE, GRENOBLE (FRANCE). CENTRE D'ETUDES NUCLEAIRES.
  - Accessibility of exact nonlinear stationary states in water-bag model computer experiments, 25:59025 (CEA-CONF-1832)
  - Dielectric properties of plasma penetrated by the helicon wave and its influence on microinstabilities in the case of anisotropic ion temperatures, 25:59083 (CEA-CONF-1826)
  - FLINA code, 25:60112 (CEA-CONF-1797)
  - Lower-hybrid wave--plasma interaction, 25:59084 (CEA-CONF-1827)
  - Optical method for studying the ion velocity in an accelerated plasma beam, 25:58978 (CEA-CONF-1829)
  - Parameter study for a Transit Time Magnetic Pumping experiment in a torus, 25:58959 (CEA-CONF-1830)
  - Plasma heating at the lower-hybrid resonance, 25:58960 (CEA-CONF-1831)
  - Techniques of continuous measurement of radioactive fission gases evolved in fuel elements, 25:57344 (CEA-R-4218)
- COMMISSARIAT A L'ENERGIE ATOMIQUE, PARIS (FRANCE).
  - Some ideas on the experience gained during the construction of fast breeder reactors, 25:60007 (CONF-710922-1)
- COMMISSARIAT A L'ENERGIE ATOMIQUE, SACLAY (FRANCE). CENTRE D'ETUDES NUCLEAIRES.
  - Development of properties of nuclear graphite obtained by a mixture of cokes, 25:58366 (CEA-CONF-1820)
  - FLINA code, 25:60112 (CEA-CONF-1797)
  - Plasma confinement in the DECA II B circularized magnetic well, 25:58958 (CEA-CONF-1807)
  - Spin amplitudes in spin-$^1/_2$ scattering, 25:59471 (CEA-N-1456)
  - Versatile analog device for identifying charged particles by their energies and ionizing powers, 25:57722 (CEA-R-4183)
- COMMONWEALTH EDISON CO., CHICAGO, ILL.
  - Dresden Nuclear Power Station, Unit 1. Supplement to Proposed Change No. 17 to Operating License DPR-2, 25:59935 (DOCKET-50010-96)
  - Dresden Nuclear Power Station, Unit 2. Additional information regarding fuel performance, 25:59941 (DOCKET-50237-203)
  - Dresden Nuclear Power Station, Unit 3. Reasons why the operation of the unit should not be limited or suspended pending completion of NEPA review, 25:59947 (DOCKET-50249-105)
  - La Salle County Station, Units 1 and 2. Preliminary safety analysis report, Amendment 5, 25:59995 (DOCKET-50373-10)
  - Quad-Cities Station, Units 1 and 2. Request to load and test in view of impending power shortage in 1972, 25:59949 (DOCKET-50254-53)
  - Zion Station, Units 1 and 2. Final safety analysis report, Amendment 16, 25:59967 (DOCKET-50295-32)
- COMPAGNIE PECHINEY, PARIS (FRANCE).
  - Development of properties of nuclear graphite obtained by a mixture of cokes, 25:58366 (CEA-CONF-1820)
- CONSOLIDATED EDISON CO. OF NEW YORK, INC., NEW YORK.
  - Indian Point Nuclear Generating Unit No. 2. Environmental report, Suppl. 2, 25:59946 (DOCKET-50247-52)
  - Indian Point Nuclear Generating Unit No. 3. Statement why construction permit should not be suspended pending completion of NEPA environmental review, 25:59965 (DOCKET-50286-39)
  - Indian Point Station, Unit No. 1. Exposure of four employees to airborne radioactivity on September 12, 1971, 25:59934 (DOCKET-50003-92)
- CONSUMERS POWER CO., JACKSON, MICH.
  - Big Rock Point Nuclear Plant. Technical specifications, 25:59938 (DOCKET-50155-93)
  - Midland Plant, Units 1 and 2. Environmental report including Appendixes A--S, 25:59978 (DOCKET-50329-27)
- COPENHAGEN UNIV. (DENMARK).
  - Preparation of isotope targets by heavy-ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
  - Preparation of targets of alpha-radioactive isotopes, 25:59638 (CONF-711002-, pp 116-21)
- CORNELL UNIV., ITHACA, N. Y. MATERIALS SCIENCE CENTER.
  - Hindered rotation at 2°K of the NO_2 impurity in KCl, 25:59199 (NYO-2150-74)

D

- DAIRYLAND POWER COOPERATIVE, LA CROSSE, WIS.
  - La Crosse Boiling Water Reactor. Coolant systems corrosion surveillance program, 25:59932 (DOCKET-1155-137)
  - La Crosse Boiling Water Reactor. Nuclear Instrumentation Automatic Gain Control System, 25:59931 (DOCKET-1155-136)
- DANISH ATOMIC ENERGY COMMISSION, RISOE. RESEARCH ESTABLISHMENT.
  - Low-temperature irradiation facility for heavy-ion radiation damage studies of metals, 25:57620 (RISO-204)
- DEPARTMENT OF ATOMIC ENERGY, BOMBAY (INDIA).
  - Conference on nuclear power, Bombay, 1/70, 25:60006 (CONF-700113)
- DETROIT EDISON CO., MICH.
  - Enrico Fermi Atomic Power Plant, Unit 2. Environmental report, construction permit stage (revised), 25:59986 (DOCKET-50341-34)
- DEUTSCHES ELEKTRONEN-SYNCHROTRON, HAMBURG (WEST GERMANY).
  - Beam expansion and increase of the Amman--Ritson luminosity limit by coupling and undamping of betatron oscillations, 25:59645 (SLAC-Trans-134)
- DIVISION OF COMPLIANCE (AEC), WASHINGTON, D.C.
  - Surry Power Station, Units No. 1 and No. 2. Request for additional information on plant construction, 25:59961 (DOCKET-50280-51)
- DIVISION OF MATERIALS AND LICENSING (AEC), WASHINGTON, D. C.
  - West Valley Reprocessing Plant. Technical specifications, change No. 15, 25:57512 (DOCKET-50201-87)
- DIVISION OF PEACEFUL NUCLEAR EXPLOSIVES (AEC), WASHINGTON, D. C.
  - Selected, annotated bibliography of the civil, industrial, and scientific uses for nuclear explosives, 25:57603 (TID-3522(Rev.9))
- DIVISION OF REACTOR LICENSING (AEC), WASHINGTON, D. C.
  - Indian Point Nuclear Generating Unit No. 2. Facility operating license, 25:59945 (DOCKET-50247-51)
  - La Crosse Boiling Water Reactor. Technical specifications, change No. 3, 25:59933 (DOCKET-1155-138)
- DIVISION OF TECHNICAL INFORMATION EXTENSION (AEC), OAK RIDGE, TENN.
  - Selected, annotated bibliography of the civil, industrial, and scientific uses for nuclear explosives, 25:57603 (TID-3522(Rev.9))
- DOUGLAS UNITED NUCLEAR, INC., RICHLAND, WASH.
  - WIGL2, self-initializing version, 25:60209 (DUN-7538)
- DOW CHEMICAL CO., GOLDEN, COLO. ROCKY FLATS DIV.
  - Evaluation of methods to recover plutonium from incinerator ash, 25:57525 (RFP-1723)
  - Investigation of fluorine interactions with common glovebox construction materials, 25:57619 (RFP-1739)
  - Preparation of actinide metal targets using special casting techniques, 25:59634 (CONF-711002-, pp 59-69)
- DU PONT DE NEMOURS (E.I.) AND CO., AIKEN, S. C. SAVANNAH RIVER LAB.
  - Hot pressing techniques for fabricating Cm_2O_3 for radioisotopic fuel forms, 25:57653 (DP-1270)
  - Prog. rpt. on ^{60}Co power and heat sources, 4--6/71, 25:57654 (DP-1279)
  - Radiolysis of liquid waste during bedrock storage, 25:57459 (DP-1264)
  - Remote decontamination of equipment in a radiochemical separations plant, 25:57517 (DP-1266)
- DU PONT DE NEMOURS (E.I.) AND CO., AIKEN, S. C. SAVANNAH RIVER PLANT.
  - Prog. rpt. on effect of SRP on environmental radioactivity, semiannual, 1--6/71, 25:57996 (DPSPU-71-30-16)
  - Safety summary report: SPERT-III fuel in Paducah demonstration Cask (Packaging of radioactive and fissile materials). Final report, 25:57703 (DPSPU-71-124-4A)
- DUQUESNE LIGHT CO., PITTSBURGH, PA.
  - Beaver Valley Power Station. Statement why construction permit should not be suspended pending completion of NEPA environmental review, 25:59982 (DOCKET-50334-26)

E

- EIDGENOESSISCHES INSTITUT FUER REAKTORFORSCHUNG, WUERENLINGEN (SWITZERLAND).
  - Core heat transfer and fluid flow in the GCFR, 25:60059 (CONF-710606-14)
- EUROPEAN ATOMIC ENERGY COMMUNITY.
  - Check of nuclear data and methods of calculation by integral experiments, 25:60036 (EURFNR-945)
  - Release of gaseous fission products from carbons, 25:58367 (EUR-4327)
- EUROPEAN ATOMIC ENERGY COMMUNITY, GEEL (BELGIUM). CENTRAL NUCLEAR MEASUREMENTS BUREAU.
  - Assay of samples for nuclear measurements by counting and chemical analysis, 25:57345 (CONF-711002-, pp 293-306)
  - Assay of samples for nuclear measurements by physical methods, 25:59640 (CONF-711002-, pp 272-82)
  - High-temperature neutron dosimeters, 25:57723 (CONF-711002-, pp 82-5)
  - Preparation of layers by electrospraying and electrophoresis, 25:58183 (CONF-711002-, pp 160-5)
  - Preparation of powder samples, 25:58181 (CONF-711002-, pp 77-81)
  - Preparation of standard layers by vacuum evaporation, 25:58182 (CONF-711002-, pp 122-33)
  - Sample preparation by metallurgical methods, 25:58179 (CONF-711002-, pp 47-58)
  - Sampling and dilution problems in radioactivity measurements, 25:57498 (CONF-711002-, pp 283-92)
- EUROPEAN COMMUNITIES, LUXEMBOURG. COMMISSION.
  - Radioactive contamination of foodstuffs in countries of the community in 1969, 25:57979 (EUR-4667)

XUM

F

FLORIDA POWER AND LIGHT CO.
- Hutchinson Island Plant, Unit No. 1. Statement why construction permit should not be suspended pending completion of NEPA environmental review, 25:59983 (DOCKET-50335-20)
- Turkey Point Plant, Units No. 3 and No. 4. Statement why construction permit should not be suspended pending completion of NEPA environmental review, 25:59948 (DOCKET-50250-50)

FLORIDA POWER CORP., ST. PETERSBURG.
- Crystal River Nuclear Generating Plant, Unit 3. Statement of reasons why construction should not be suspended pending completion of NEPA environmental review, 25:59969 (DOCKET-50302-26)

FLORIDA STATE UNIV., TALLAHASSEE.
- Prog. rpt. on cell response to penetration by nucleic acid, annual, 9/70--8/71, 25:60282 (ORO-3885-3)

FLORIDA UNIV., GAINESVILLE. DEPT. OF METALLURGICAL AND MATERIALS ENGINEERING.
- Prog. rpt. on quantitative determination of the structure-property relationships in nuclear fuel element materials, 3/15/71--6/15/71, 25:58389 (SRO-552-8)

G

GENERAL ELECTRIC CO., CINCINNATI, OHIO. SPACE DIV.
- SNAP-8 refractory boiler development, 25:60138 (N-71-19497)

GENERAL ELECTRIC CO., PLEASANTON, CALIF. VALLECITOS NUCLEAR CENTER.
- Prog. rpt. on fission gas re-solution rates, 4--6/71, 25:58411 (GEAP-12217)

GENERAL ELECTRIC CO., SAN JOSE, CALIF. ATOMIC POWER EQUIPMENT DEPT.
- Reactor primary coolant system rupture study. Progress report No. 24, January--June 1971, 25:60061 (GEAP-10207-24)

GENERAL ELECTRIC CO., SAN JOSE, CALIF. NUCLEAR FUELS DEPT.
- Midwest Fuel Recovery Plant. Amendment No. 18, supplement No. 1 to amendment No. 15, 25:57515 (DOCKET-50268-15)

GENERAL ELECTRIC CO., SUNNYVALE, CALIF.
- Review of fast reactor operating experience, 25:60094 (CONF-710922-2)

GENERAL ELECTRIC CO., SUNNYVALE, CALIF. BREEDER REACTOR DEVELOPMENT OPERATION.
- Southwest Experimental Fast Oxide Reactor. Cladding temperatures for the FRED poison rod, 25:60153 (DOCKET-50231-97)
- Southwest Experimental Fast Oxide Reactor. Ninth quarterly plant operation report, May 1--July 31, 1971, 25:60154 (DOCKET-50231-98)
- Southwest Experimental Fast Oxide Reactor. Technical specifications, Proposed Change No. 7, 25:60152 (DOCKET-50231-96)
- Southwest Experimental Fast Oxide Reactor. Technical specifications proposed change No. 8, 25:60155 (DOCKET-50231-99)

GEOLOGICAL SURVEY, DENVER, COLO.
- Log of Hydrologic Test Well 1, Tatum dome area, Lamar County, Mississippi. Dribble-6, 25:57562 (USGS-474-110)
- Log of Hydrologic Test Well 2, Tatum dome area, Lamar County, Mississippi. Dribble-7, 25:57563 (USGS-474-111)
- Structure of the southeastern Mississippi region, 25:57596 (USGS-474-129)
- Velocity cross section 5, extending southwest from Tatum dome, Lamar County, Miss, 25:57595 (USGS-474-112)

GEOLOGICAL SURVEY, PORTLAND, OREG. WATER RESOURCES DIV.
- Relations among radionuclide content and physical, chemical, and mineral characteristics of Columbia River sediments, 25:57561 (TID-25786)

GEORGIA POWER CO., ATLANTA.
- Edwin I. Hatch Nuclear Plant, Unit 2. Preliminary safety analysis report, Amendment 10, 25:59992 (DOCKET-50366-16)
- Edwin I. Hatch Nuclear Plant, Unit 2. Preliminary safety analysis report, amendment No. 11, 25:59993 (DOCKET-50366-17)
- Edwin I. Hatch Nuclear Power Plant, Unit 1. Statement why construction permit should not be suspended pending completion of NEPA environmental review, 25:59976 (DOCKET-50321-24)

GOSUDARSTVENNYI KOMITET PO ISPOL'ZOVANIYU ATOMNOI ENERGII SSSR, OBNINSK. FIZIKO-ENERGETICHESKII INSTITUT.
- Analysis of uranium burn-up and plutonium build-up in fast reactors, 25:60095 (IAEA-R-742-F)

GRENOBLE UNIV. (FRANCE). FACULTE DES SCIENCES.
- Measurement device and numerical analysis of electrical resistivity from 4 to 300°K. Application to Nb--Hf alloys, 25:58929 (FRNC-TH-72)

GULF GENERAL ATOMIC CO., SAN DIEGO, CALIF.
- Prog. rpt. on controlled thermonuclear research, 8/70--7/71, 25:59073 (GULF-GA-A-10807)

GULF GENERAL ATOMIC, INC., SAN DIEGO, CALIF.
- Gas cooled fast breeder reactor, 25:60009 (CONF-710922-5)

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- Application of photoinduced reactions to nuclear materials safeguards problems. Project summary report, July 1, 1970--June 30, 1971, 25:57704 (GULF-RT-A-10826)
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H

HAHN-MEITNER-INSTITUT FUER KERNFORSCHUNG, BERLIN (WEST GERMANY).
- Chemical aspects of reactor safety, 25:60116 (HMI-B-113)

HANFORD ENGINEERING DEVELOPMENT LAB., RICHLAND, WASH.
- Biaxial stress rupture properties of annealed 316 stainless steel after EBR-II irradiation, 25:58297 (HEDL-TME-71-72)
- CCTL Mark II subassembly shipping procedure, 25:57612 (HEDL-TME-71-114)
- Mechanical properties of fast reactor irradiated austenitic stainless steel weldment materials, 25:58296 (HEDL-SA-196)
- Translating elevated temperature material properties into rules for structural design, 25:60115 (HEDL-SA-164)

HUMPHREYS CORP., CONCORD, N.H. TAFA DIV.
- Induction plasma nozzle tests, 25:57640 (N-71-22591)

I

ICN/TRACERLAB, WALTHAM, MASS.
- Pilgrim Nuclear Power Station. Preoperational environmental radiation survey program. Quarterly report, April 1--June 30, 1971, 25:59966 (DOCKET-50293-56)

IDAHO NUCLEAR CORP., IDAHO FALLS.
- First product denitration campaign with enriched uranium at ICPP, 25:57397 (IN-1475)
- Process chemistry for burner product from graphite fuels containing niobium, 25:57519 (IN-1484)

ILLINOIS INST. OF TECH., CHICAGO. DEPT. OF CHEMISTRY.
- Prog. rpt. on high temperature chemistry: fundamentals of effusion and thermodynamics of materials, final, 6/61--8/71, 25:57435 (COO-1029-39)

ILLINOIS UNIV., URBANA. DEPT. OF PHYSICS.
- Ambiguities in R-matrix parameters for interfering resonances with two fission channels, 25:59829 (COO-2022-11)
- Multilevel analysis of ^{235}U scattering cross section data, 25:59828 (COO-2022-10)

INDIANA AND MICHIGAN ELECTRIC CO., NEW YORK.
- Donald C. Cook Nuclear Plant, Units 1 and 2. Final safety analysis report, Amendment 17, Vol. 8, 25:59973 (DOCKET-50315-49)

INDIANA AND MICHIGAN POWER CO., NEW YORK.
- Donald C. Cook Nuclear Plant, Units 1 and 2. Final safety analysis report, Amendment 17, Vol. 7, 25:59972 (DOCKET-50315-48)

INDIANA UNIV., BLOOMINGTON. DEPT. OF PHYSICS.
- Equivalence of Regge and optical models, 25:59421 (COO-2009-30)

INSTITUT ATOMNOI ENERGII, MOSCOW (USSR).
- Heat exchange crisis during movement of boiling water along fuel rod banks, 25:57638 (IAE-2014)

INSTITUT FUER PLASMAPHYSIK, G.M.B.H. GARCHING (WEST GERMANY).
- Asymptotic behavior of the two-stream instability, 25:59062 (IPP-6/97)
- Simple low-loss coupling method for RF heating of plasma ions by electrostatic ion-cyclotron waves, 25:58962 (IPP-IV-25)
- Tachyon mechanics and classical tunnel effect, 25:59556 (IPP-6/95)
- Vacuum magnetic fields of linear stellarators with shaped coils, 25:59074 (IPP-1/119)
- Validity of quasi-linear approximation for turbulent plasmas, 25:59027 (IPP-6/94)

INSTITUTE OF NUCLEAR PHYSICS, KRAKOW (POLAND).
- Pulsed neutron method for uranium well logging, 25:57560 (INP-732)

INSTITUTE OF NUCLEAR RESEARCH, WARSAW (POLAND).
- Intercomparison measurements of SKODA and INR calorimeters on EWA-10 reactor, 25:57875 (INR-1319)
- Possible uses of plasma in powder metallurgy, with particular reference to spheroidization, 25:58187 (SCL-T-710281)
- Primary coolant purification system in the EWA-10 reactor, 25:60157 (INR-1316)
- Radiographical control of thickwalled welds and castings by using of betatron, 25:57678 (INR-1204)

INSTITUTUL DE FIZICA ATOMICA, BUCHAREST (ROMANIA).
- Absolute measurement of ^{239}Pu fission cross-section for 2200 m/sec neutrons, 25:59777 (IFA-NR-33)
- Determination of the concentration of ^{59}Fe in the coolant water of VVR-S reactor, 25:57346 (IFA-FR-82)
- Polarization effects in nuclear transfer reactions, 25:59831 (IFA-CRD-41)
- Program for the computing of the scattering cross-

sections in heavy water, 25:59671 (IFA-DNBR-3)
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA (AUSTRIA).
  Conference on advances in physical and biological radiation detectors, Vienna, 11/70, 25:57726 (STI/PUB-269)
  Determination of absorbed dose in reactors, 25:60160 (STI/DOC-10/127)
IOWA ELECTRIC LIGHT AND POWER CO., CEDAR RAPIDS.
  Duane Arnold Energy Center. Statement why construction permit should not be suspended pending completion of NEPA environmental review, 25:59979 (DOCKET-50331-28)
ISRAEL ATOMIC ENERGY COMMISSION, BEERSHEBA. NUCLEAR RESEARCH CENTER-NEGEV.
  Diffusion of Co in Pu, 25:58212 (NRCN-268)

J

JAPAN ATOMIC ENERGY RESEARCH INST., TOKAI. TOKAI RESEARCH ESTABLISHMENT.
  Measurement of the plasma current distribution in a tokamak device with alpha-particles injected transverse or parallel to the toroidal axis, 25:58980 (JAERI-Memo-4531)
JAPAN ATOMIC ENERGY RESEARCH INST., TOKYO.
  ^{208}Pb(γ,n)^{207}Pb reaction near threshold, 25:59778 (JAERI-Memo-4520)
  Benchmark test by various cross section sets for fast reactor analysis in Japan, 25:60210 (JAERI-Memo-4406)
  Calculation code for thermal neutron multi-group reactor constants: THERMOS-MUG, 25:60225 (JAERI-Memo-4394)
  Conceptual design of the reactant flow loop for fissiochemical studies, 25:57613 (JAERI-Memo-4446)
  Design of Experimental Multi-Purpose High Temperature Reactor, 25:60011 (JAERI-Memo-4419)
  Microwave interferometric measurements in medium-beta torus (JFT-2), 25:58979 (JAERI-Memo-4530)
JERSEY CENTRAL POWER AND LIGHT CO., MORRISTOWN, N. J.
  Forked River Nuclear Generating Station, Unit No. 1. Preliminary safety analysis report, Amendment 11, 25:59991 (DOCKET-50363-18)
  Oyster Creek Nuclear Power Plant, Unit No. 1. Failure of isolation condenser line break protection, 25:59909 (DOCKET-50219-149)
JET PROPULSION LAB., PASADENA, CALIF.
  Electric space potential in a cesium thermionic diode, 25:58838 (N-71-26273)
  Thermionic energy conversion system design, 25:57656 (N-71-18512)
JOINT INST. FOR NUCLEAR RESEARCH, DUBNA (USSR).
  Interaction of high-energy radiation with matter, 25:59508 (ORNL-tr-2514)
  Search for $\pi^+ \to e^+ + \nu$/sub e/ $+ e^+ + e^-$ decay, 25:59255 (BNL-tr-451)
  Search for the decay $\mu^+ \to e^+ + e^+ + e^-$, 25:59254 (BNL-tr-449)
  Statistical reconstruction of inelastic π-N and N-N interactions in the superhigh energy region, 25:59472 (JINR-P2-6022)
JOINT INST. FOR NUCLEAR RESEARCH, DUBNA (USSR). LAB. OF NEUTRON PHYSICS.
  Determination of the neutron--neutron scattering length from a kinematically complete experiment with the reaction ^{3}H(t,n^{4}He)n, 25:59506 (JINR-E15-5905)
JOINT INST. FOR NUCLEAR RESEARCH, DUBNA (USSR). LAB. OF NUCLEAR PROBLEMS.
  Angular distribution of the low energy neutrons from the nuclear μ-capture in sulfur and calcium, 25:59738 (JINR-P1-6029)
  Fast thermochemical methods of separation of radioactive elements. I, 25:57480 (JINR-P6-5955)
JOINT INST. FOR NUCLEAR RESEARCH, DUBNA (USSR). LAB. OF NUCLEAR REACTIONS.
  Electromigration separation of transuranium elements in solutions of ethilendiamintetracetic and cyclohex andiamintetracetic acids, 25:57520 (JINR-E6-5952)
  Production and decay of compound nuclei in high-energy heavy ion reactions, 25:59779 (JINR-P7-5912)
JOINT INST. FOR NUCLEAR RESEARCH, DUBNA (USSR). LAB. OF THEORETICAL PHYSICS.
  Approximate methods for solving Schroedinger equation with marginally singular potential, 25:59205 (JINR-E2-6043)
  Calculation of neutron equilibrium pairing in spherical single closed shell nuclei, 25:59833 (JINR-E4-5907)
  Coherent state method and the quark model, 25:59448 (JINR-E2-6025)
  Deep inelastic electroproduction of hadrons on a photon target, 25:59333 (JINR-E2-6036)
  Intranuclear cascades in light nuclei, 25:59265 (JINR-P2-5991)
  Nuclear center of mass coordinate in Bloch--Horowitz theory, 25:59832 (JINR-E4-5890)
  Phenomenological study of inclusive single particle spectra in the triple Regge limit, 25:59505 (JINR-E2-6031)
  Quasipotential formalism for the two-particle system with spins 0 and $^1/_2$, 25:59422 (JINR-E2-6046)
  Transformation properties of states at infinite momentum II, 25:59321 (JINR-E2-5993)
JUNTA DE ENERGIA NUCLEAR, SACAVEM (PORTUGAL). LABORATORIO DE FISICA E ENGENHARIA NUCLEARES.
  FORTRAN LFEN-FR 10: diffusion length of thermal neutrons in moderators from experimental distributions of neutron flux, 25:60226 (LFEN-NI.-60-a)
  Introduction to the study of the problem of scattering of slow neutrons by condensed matter, 25:59673 (LFEN-NI.-51-a)
  Techniques for preparation of UO$_2$--niobium (or molybdenum) cermets, 25:58348 (LFEN-NI.-53-a)
  Thermodynamic behavior of the ''multiflash'' evaporator, 25:57616 (LFEN-NI.-54-a)

K

KERNFORSCHUNGSANLAGE, JUELICH (WEST GERMANY).
  Release of gaseous fission products from carbons, 25:58367 (EUR-4327)
KERNFORSCHUNGSANLAGE, JUELICH (WEST GERMANY). INSTITUT FUER FESTKOERPERFORSCHUNG.
  Determination of the anisotropy of the threshold energy for the production of Frenkel defects in Ta, 25:59125 (JUL-729-FF)
KERNFORSCHUNGSANLAGE, JUELICH (WEST GERMANY). INSTITUT FUER REAKTORBAUELEMENTE.
  Heat transfer of tube shaped fuel elements of the central channel of a reactor of the type natural uranium-gas-graphite, 25:57639 (JUL-753-RB)
KERNFORSCHUNGSANLAGE, JUELICH (WEST GERMANY). INSTITUT FUER REAKTORENTWICKLUNG.
  Technical and scientific position as well as prospect for nuclear energy in the engineering of the Federal Republic of Germany. II, 25:60012 (JUL-775-RG)
KERNFORSCHUNGSANLAGE, JUELICH (WEST GERMANY). INSTITUT FUER REAKTORWERKSTOFFE.
  Investigation and preparation of spherical doped UO$_2$ fuel particles, 25:58347 (JUL-730-RW)
KERNFORSCHUNGSZENTRUM, KARLSRUHE (WEST GERMANY).
  Fast Breeder Project. Fourth quarterly report 1970, 25:60010 (EURFNR-902)
KERNFORSCHUNGSZENTRUM, KARLSRUHE (WEST GERMANY). INSTITUT FUER ANGEWANDTE REAKTORPHYSIK.
  Basic problems of the development of fast breeder reactors, 25:60008 (CONF-710922-4)
  Technical and scientific position as well as prospect for nuclear energy in the engineering of the Federal Republic of Germany. II, 25:60012 (JUL-775-RG)
KERNFORSCHUNGSZENTRUM, KARLSRUHE (WEST GERMANY). INSTITUT FUER EXPERIMENTELLE KERNPHYSIK.
  Measurement of the circular polarization of γ radiation after capture of polarized thermal neutrons in nuclei, 25:59780 (KFK-1401)
KERNFORSCHUNGSZENTRUM, KARLSRUHE (WEST GERMANY). INSTITUT FUER HEISSE CHEMIE.
  Aqueous reprocessing of fast breeder fuel elements, 25:57518 (EURFNR-888)
KERNFORSCHUNGSZENTRUM, KARLSRUHE (WEST GERMANY). INSTITUT FUER NEUTRONENPHYSIK UND REAKTORTECHNIK.
  Check of nuclear data and methods of calculation by integral experiments, 25:60036 (EURFNR-945)
  Closed gas turbine cycle for a 1000-MWe gas-cooled Fast Breeder Reactor, 25:60137 (KFK-1409)
  Gas Breeder-memorandum, 25:60013 (KFK-1375)
  Strategies for accelerating two-dimensional SN methods by coarse lattice technique, 25:60224 (EURFNR-899)
KERNFORSCHUNGSZENTRUM, KARLSRUHE (WEST GERMANY). INSTITUT FUER REAKTORENTWICKLUNG.
  Change of interpretation of the intermediate heat exchanger for the sodium cooled reactor using ferritic steel design, 25:57614 (KFK-1387)
  Inherent properties of the various primary circuit designs for sodium-cooled reactors, 25:60060 (EURFNR-904)
  Propagation of local disturbances in the core of fast sodium-cooled reactor and their significance for reactor safety, 25:60117 (KFK-1380)
KERNKRAFTWERK RWE-BAYERNWERK G.M.B.H., GUNDREMMINGEN (WEST GERMANY).
  Gundremmingen Nuclear Power Plant operations report, 7/71, 25:59914 (TID-25818)
KYOTO UNIV. (JAPAN). RESEARCH REACTOR INST.
  Chemical separation in an isotope separation on-line (ISOL) system, 25:57481 (KURRI-TR-76, pp 8-14)
  Conference on nuclei with short life, Kumatori, Osaka, Japan, 6/30--7/1/69, 25:59834 (KURRI-TR-76)
  Experiment on short lived nuclei, 25:59781 (KURRI-TR-76, pp 19-20)
  Measurement for short lived nuclei, 25:59782 (KURRI-TR-76, pp 21-6)
  Nuclei far off beta stability line and gross theory of nuclei, 25:59836 (KURRI-TR-76, pp 3-6)
  Rapid chemical separation, 25:57521 (KURRI-TR-76, pp 15-18)
  Why we study nuclei far off stability line, 25:59835 (KURRI-TR-76, pp 1-2)

L

LOCKHEED MISSILES AND SPACE CO., SUNNYVALE, CALIF.
  Study of nuclear explosion services fielding system. Volume II. Supporting data (appendixes A through H).

XUM

- Final report, Phase II, 25:57601 (LMSC-D-177630(Vol.2))

LOS ALAMOS SCIENTIFIC LAB., N. MEX.
- Bounds on the bandwidth of bipartite graphs, 25:60274 (LA-4744)
- Cross sections for (π^+,p) reactions on ^{9}Be, ^{12}C, and ^{16}O, 25:59710 (LA-DC-12781)
- Dispersion relations for nuclear structure physics, 25:59691 (LA-DC-12958)
- Dividing head tabulations, 25:60273 (LA-4421)
- ENDF formats and procedures for photon production and interaction data, 25:59838 (LA-4549)
- Finite-difference solution of axially symmetric nuclear single-particle potentials, 25:59839 (LA-4735)
- Formalism for the [polarized] T(d,n)^{4}He and ^{3}He(d,p)^{4}He reactions, 25:59837 (LA-4492)
- New measurements of $(\pi^+,2p)$ reactions on light nuclei, 25:59709 (LA-DC-12389)
- Nuclear chemistry program for Los Alamos Meson Physics Facility, 25:59642 (LA-DC-12795)
- Prog. rpt. on Advanced Plutonium Fuels Program, 1--3/71, 25:58344 (LA-4693)
- Prog. rpt. on medium-energy physics program, 7/71, 25:59641 (LA-4753)
- Prog. rpt. on space electric power R and D program, Pt. I, 7/31/71, 25:57615 (LA-4746)
- Thermodynamic properties of $PuRu_2$ from EMF measurements, 25:58211 (LA-4758)

LOUISIANA POWER AND LIGHT CO., NEW ORLEANS.
- Waterford Steam Electric Station, Units 3 and 4. Application withdrawn, 25:59997 (DOCKET-50382-12)
- Waterford Steam Electric Station, Units 3 and 4. Preliminary safety analysis report, Amendment 6, 25:59996 (DOCKET-50382-11)

LOVELACE FOUNDATION FOR MEDICAL EDUCATION AND RESEARCH, ALBUQUERQUE, N. MEX.
- Effects of airblast on sheep in two-man foxholes, 25:60272 (DASA-2711)

LYON UNIV. (FRANCE). INSTITUT DE PHYSIQUE NUCLEAIRE.
- Non-exhaustive restatement of the angular momentum reduction in the three-body problem, 25:59206 (LYCEN-7118)

M

MCDONNELL DOUGLAS ASTRONAUTICS CO., RICHLAND, WASH. DONALD W. DOUGLAS LABS.
- Thermionic energy conversion system design, 25:57656 (N-71-18512)

MAGYAR TUDOMANYOS AKADEMIA KOZPONTI FIZIKAI KUTATO INTEZETE, BUDAPEST.
- Correlation technique at pulsed neutron sources, 25:59672 (KFKI-71-45)
- Program for the determination of neutron spectra from activation data, 25:57725 (KFKI-71-22)
- Use of negative time-like states, 25:59609 (KFKI-71-39)

MASON AND HANGER-SILAS MASON CO., INC., AMARILLO, TEX.
- Static detector, 25:60275 (MHSMB-24)

MILLSTONE POINT CO., HARTFORD, CONN.
- Millstone Nuclear Power Station, Unit 1. Abnormal occurrence No. AO-71-19, 25:59910 (DOCKET-50245-94)
- Millstone Nuclear Power Station, Unit 1. Abnormal Occurrence No. AO-71-20, 25:59912 (DOCKET-50245-99)
- Millstone Nuclear Power Station, Unit No. 1. Statement of reasons for non-suspension of provisional operating license, 25:59944 (DOCKET-50245-98)
- Millstone Nuclear Power Station, Unit No. 2. Statement why construction permit should not be suspended pending completion of NEPA environmental review, 25:59984 (DOCKET-50336-23)

MOUND LAB., MIAMISBURG, OHIO.
- ATMX-500 rail car modification, 25:57705 (MLM-1812)
- Neutron emission rate reduction in PuO_2 by oxygen exchange, 25:57655 (MLM-1844)
- Quantitative analysis of a cermet sphere, 25:58388 (MLM-OP-71006)

N

NANCY UNIV. (FRANCE). FACULTE DES SCIENCES.
- Effect of neutron irradiation on high temperature mechanical properties of age-hardened 80-20 Ni--Cr alloy, 25:58295 (FRNC-TH-64)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, CLEVELAND, OHIO. LEWIS RESEARCH CENTER.
- Analytic study of an electric stepping motor drive for a nuclear reactor control drum, 25:60193 (N-71-26979)
- Preliminary impact speed and angle criteria for design of a nuclear airplane fission product containment vessel, 25:60192 (N-71-25411)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, HUNTSVILLE, ALA. GEORGE C. MARSHALL SPACE FLIGHT CENTER.
- Risk of solar proton events to space missions, 25:58853 (N-71-27792)

NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C.
- National Bureau of Standards Reactor. Operations report, January 1--June 30, 1971, 25:60150 (DOCKET-50184-32)
- National Bureau of Standards Reactor. Replacement to primary system main heat exchanger, 25:60151 (DOCKET-50184-33)

NATIONAL INST. FOR METALLURGY, JOHANNESBURG (SOUTH AFRICA).
- Calculation of the equilibrium distribution of metal-ion complexes in multicomponent aqueous systems, 25:57398 (NIM-1093)
- Three-dimensional predominant-area and solubility diagrams for uranyl carbonate and uranyl sulphate systems at 25°C, 25:57399 (NIM-1144)

NATIONAL INST. OF RADIOLOGICAL SCIENCES, CHIBA (JAPAN).
- Final report of research project on plutonium hazards, 4/66--3/70, 25:57598 (NIRS-Pu-8)

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, LAS VEGAS, NEV. EARTH SCIENCES LABS.
- Earthquakes on and around Nevada Test Site, 1950--71, 25:57589 (CGS-746-12)

NEW ENGLAND PLANNING COMMITTEE.
- Vermont Yankee Nuclear Power Station. Pilgrim Nuclear Power Station. Maine Yankee Atomic Power Station. Millstone Nuclear Power Station. How New England regional power supply would be affected by delay and shutdown of nuclear capacity, 25:59956 (DOCKET-50271-63)

NEW ENGLAND EXCHANGE, WEST SPRINGFIELD, MASS.
- New England Power Exchange, 25:59907 (CONF-710606-15)
- Vermont Yankee Nuclear Power Station. Pilgrim Nuclear Power Station. Maine Yankee Atomic Power Station. Millstone Nuclear Power Station. How New England regional power supply would be affected by delay and shutdown of nuclear capacity, 25:59956 (DOCKET-50271-63)

NEW YORK OPERATIONS OFFICE (AEC), N. Y. HEALTH AND SAFETY LAB.
- Prog. rpt. on Fallout Program, 6/71--9/71, 25:57980 (HASL-245)
- Prog. rpt. on Fallout Program, 6/71--9/71, 25:57981 (HASL-245(App.))

NORTH CAROLINA STATE UNIV., RALEIGH. DEPT. OF CHEMICAL ENGINEERING.
- Radiation induced ionic polymerization, 25:57450 (ORO-3667-1)

NORTHEAST UTILITIES SERVICE CO., HARTFORD, CONN.
- Millstone Nuclear Power Station, Unit 1. Emergency Core Cooling System conformance to new AEC adopted interim acceptance criteria, 25:59943 (DOCKET-50245-95)
- Millstone Nuclear Power Station, Unit No. 1. Start-up, 25:59911 (DOCKET-50245-96)

NORTHERN STATES POWER CO., MINNEAPOLIS, MINN.
- Monticello Nuclear Generating Plant, Unit 1. HPCI problems experienced during start-up, 25:59913 (DOCKET-50263-88)
- Monticello Nuclear Generating Plant, Unit 1. Statement why operating license should not be suspended pending completion of the NEPA environmental review, 25:59953 (DOCKET-50263-87)
- Monticello Nuclear Generating Plant, Unit 1. Technical specification amended change request No. 2, 25:59952 (DOCKET-50263-86)
- Prairie Island Nuclear Generating Plant, Units 1 and 2. Statement why construction permits should not be suspended pending completion of NEPA environmental review, 25:59963 (DOCKET-50282-41)

NUCLEAR-CHICAGO CORP., AUSTIN, TEX. TEXAS NUCLEAR DIV.
- Study of particulate heterogeneity effects in radioisotope x-ray spectrometry, 25:57300 (ORO-3847-2)

NUCLEAR FUEL SERVICES, INC., ROCKVILLE, MD.
- West Valley Reprocessing Plant. Final safety analysis report, revised Tornado Missile Analysis, 25:57513 (DOCKET-50201-88)

NUCLEAR FUEL SERVICES, INC., WEST VALLEY, N.Y.
- West Valley Reprocessing Plant. Addendum to safety evaluation for transfer and processing of plutonium nitrate--uranyl nitrate solutions, 25:57514 (DOCKET-50201-89)

NUCLEAR MATERIALS AND EQUIPMENT CORP., APOLLO, PA. ENERGY CONVERSION DIV.
- Prog. rpt. on radioisotope-powered cardiac pacemaker program, 5--7/71, 25:57657 (NUMEC-4189-6)

O

OAK RIDGE NATIONAL LAB., TENN.
- Analysis of repair in human DNA by 5-bromodeoxyuridine photolysis, 25:60268 (CONF-711014-1)
- Calculation of the nucleon- and pion-induced star and flux distributions from 400-GeV proton interactions in iron, 25:59507 (ORNL-4673)
- Cask and waste container cooling studies, 25:57706 (ORNL-TM-3545)
- Chemistry, 25:57298 (ORNL-4676, pp 73-138)
- Chest clearance of inhaled ^{60}Co oxide, 25:57995 (CONF-711013-1)
- Deformation and rupture behavior of light-water reactor fuel cladding, 25:60118 (ORNL-4727)
- Development of manufacturing procedures for HFIR fuel plates to ORNL specification, 25:58349 (ORNL-4713)
- Effect of alloying and purity on the formation and ordering of voids in BCC metals, 25:58300 (ORNL-TM-3496)
- Effects of structural imperfections on voids in aluminum, 25:58298 (ORNL-TM-3493)

  ELAN-2B, pilot plant for ^{137}Cs and ^{90}Sr sources, 25:57482 (ORNL-tr-2535)
  Elastic scattering of 40-MeV protons from ^{48}Ti, /sup nat/Cr, and ^{64}Zn: tabulated differential cross sections, 25:59739 (ORNL-TM-3591)
  Error analysis of ecological models, 25:57947 (CONF-710501-35)
  Evaluation of plutonium use in high-temperature gas-cooled reactors, 25:60097 (ORNL-TM-3525)
  Experimental investigation of fabrication of Th--20 wt. percent U for the UMBR fuel element, 25:58185 (ORNL-TM-3499)
  Experimental investigation of neutron streaming through the grid-plate shield of the fast flux test facility, 25:60158 (ORNL-TM-3514)
  Failure of aluminum tubing in the ORNL 86-inch cyclotron, 25:59643 (ORNL-TM-3523)
  Failures of threaded fittings and fasteners at nuclear facilities, 25:57618 (ORNL-TM-3570)
  Heat transfer from electrically heated rods during a simulated loss-of-coolant accident, 25:60114 (CONF-711103-1)
  Mass transfer between Hastelloy N and Haynes alloy No. 25 in a molten sodium fluoroborate mixture, 25:58169 (ORNL-TM-3488)
  Materials development, 25:58168 (ORNL-4676, pp 139-233)
  Molten-salt processing and preparation, 25:57522 (ORNL-4676, pp 234-71)
  Molten-Salt Reactor Experiment, 25:60096 (ORNL-4676, pp 1-20)
  Molten-salt reactor program semiannual progress report for period ending February 28, 1971, 25:60014 (ORNL-4676)
  MSBR design and development, 25:60015 (ORNL-4676, pp 21-72)
  Neutron-capture-γ ray spectrum calculations for materials for possible use in a ^{252}Cf neutron activation facility, 25:57796 (ORNL-TM-3457)
  ORNL isotopic power fuel quarterly report for period ending June 30, 1971, 25:57658 (ORNL-4723)
  ORRIBLE: a computer program for flow and temperature distribution in LMFBR fuel rod bundles, 25:60062 (ORNL-TM-3516)
  Preparation of neutron dosimeters for reactors, 25:57724 (CONF-711002-, pp 86-90)
  Preparation of self-supporting, metallic foils of isotopic chromium, 25:59633 (CONF-711002-, pp 39-46)
  Probabilistic model for estimating the operating cost of an electric power generating system, 25:60280 (ORNL-TM-3549)
  Production and crystal growth of isotopic rare-earth metals, 25:58184 (CONF-711002-, pp 181-90)
  Prog. rpt. on fast reactor shielding, 8/71, 25:60055 (ORNL-TM-3573)
  Proper use of information on organ and body burdens of radioactive material, 25:58024 (CONF-711104-1)
  Proposal for computer assisted data acquisition for ORNL fusion experiments, 25:59075 (ORNL-TM-3593)
  Radioactive contamination of copper recovered from ore fractured with nuclear explosions, 25:57523 (ORNL-4677)
  Remote inspection of welded joints, 25:57680 (ORNL-TM-3561)
  Review of experiments on nucleon--nucleon bremsstrahlung, 25:59241 (CONF-710915-2)
  Size classification of submicron particles by a low-pressure cascade impactor, 25:57573 (ORNL-4226)
  Study of the formation of creep cavities in powder-metallurgy tungsten, 25:58213 (ORNL-TM-3350)
  Summary of the campaign during February 1969 to process six irradiated HFIR targets in the transuranium processing plant, 25:57524 (ORNL-TM-3343)
  Target thickness and uniformity measurements using charged particles, 25:57863 (CONF-711002-, pp 307-20)
  Third international symposium on research materials for nuclear measurements, Gatlinburg, Tenn., 10/71, 25:59632 (CONF-711002)
  Tritium-containing targets for high-yield neutron generators, 25:59670 (CONF-711002-, pp 166-80)
  Tubing fabrication parameters and their application to texture control in zircaloy tubing, 25:58186 (ORNL-TM-3500)
  Use of an electromagnetic isotope separator in preparing special research samples, 25:57650 (CONF-711002-, pp 10-20)
  Void formation in neutron irradiated metals, 25:58299 (ORNL-TM-3495)
OHIO STATE UNIV., COLUMBUS. DEPT. OF CHEMISTRY.
  Prog. rpt. on kinetics of ionizing-radiation induced reactions in organic compounds, annual, 12/70--11/71, 25:57458 (COO-1116-17)
OKLAHOMA UNIV. RESEARCH INST., NORMAN.
  Formation energies of individual vacancies in alkali halides, 25:60281 (ORO-3344-4)
OMAHA PUBLIC POWER DISTRICT, NEBR.
  Fort Calhoun Station, Unit No. 1. Statement establishing that the station should not be suspended pending completion of environmental review, 25:59964 (DOCKET-50285-49)
OREGON STATE UNIV., CORVALLIS.
  New measurements of $(\pi^+,2p)$ reactions on light nuclei, 25:59709 (LA-DC-12389)
OREGON UNIV., PORTLAND. MEDICAL SCHOOL.
  Detection of antinuclear antibodies in NAB and other mouse strains, 25:60285 (RLO-2226-T-3-8)

P

PACIFIC GAS AND ELECTRIC CO., SAN FRANCISCO, CALIF.
  Diablo Canyon Nuclear Power Plant, Units 1 and 2. Statement why construction permits should not be suspended pending completion of NEPA environmental review, 25:59958 (DOCKET-50275-16)
PARIS UNIV. (FRANCE). FACULTE DES SCIENCES.
  Deformation and ultimate strength of a concrete under triaxial stress, 25:58415 (FRNC-TH-61)
  Mechanism of reactions (d,p) and (d,t) induced by low energy (120 to 200 keV) deuterons on ^{9}Be. Determination of characteristics of excited levels of ^{11}B obtained by reactions ^{9}Be + d, 25:59827 (CEA-R-4070)
PARIS UNIV., ORSAY (FRANCE).
  Determination of electromagnetic transition probabilities from measurements of mean lives of excited nuclear states; application to ^{140}Ce, ^{191}Pt, and ^{135}La nuclei, 25:59776 (FRNC-TH-56)
PARIS UNIV., ORSAY (FRANCE). LABORATOIRE DE PHYSIQUE DES PLASMAS.
  High-frequency resonant plasma, 25:59063 (NP-19031)
PENNSYLVANIA POWER AND LIGHT CO., ALLENTOWN.
  Susquehanna Steam Electric Station, Units 1 and 2. Preliminary safety analysis report, Amendment 1, 25:59998 (DOCKET-50387-10)
  Susquehanna Steam Electric Station, Units 1 and 2. Preliminary safety analysis report, amendment No. 2, 25:59999 (DOCKET-50387-11)
PHILADELPHIA ELECTRIC CO., PA.
  Limerick Generating Station, Units 1 and 2. Preliminary safety analysis report, Amendment 13, 25:59990 (DOCKET-50352-22)
  Limerick Generating Station, Units No. 1 and No. 2. Responses to comments made by Department of the Interior, Fish and Wildlife Service, 25:59989 (DOCKET-50352-21)
  Peach Bottom Atomic Power Station, Units 2 and 3. Statement of reasons establishing that construction permits should not be suspended pending completion of NEPA environmental review, 25:59959 (DOCKET-50277-24)
POWER AUTHORITY OF THE STATE OF NEW YORK.
  James A. Fitzpatrick Nuclear Power Plant. Action taken to correct items of nonconformance found on August 16--18, 1971, 25:59980 (DOCKET-50333-31)
  James A. Fitzpatrick Nuclear Power Plant. Statement why construction permits should not be suspended pending completion of NEPA environmental review, 25:59981 (DOCKET-50333-32)
POWER REACTOR DEVELOPMENT CO., DETROIT, MICH.
  Enrico Fermi Atomic Power Plant. Report for May 1971, 25:59908 (DOCKET-50016-130)
PRINCETON UNIV., N. J. PLASMA PHYSICS LAB.
  Use of long-wavelength, high powered lasers for controlled thermonuclear fusion, 25:59054 (MATT-782)
PUBLIC SERVICE CO. OF COLORADO, DENVER.
  Fort St. Vrain Nuclear Generating Station, Unit 1. Statement establishing that the station should not be suspended pending completion of environmental review, 25:59955 (DOCKET-50267-34)
PUBLIC SERVICE ELECTRIC AND GAS CO., NEWARK, N.J.
  Salem Nuclear Generating Station, Units 1 and 2. Statement why the construction permits should not be suspended pending completion of the NEPA environmental review, 25:59957 (DOCKET-50272-20)

R

REACTOR CENTRUM NEDERLAND, PETTEN.
  Determination of effective cross sections of fission products for fast breeders in the fast-thermal coupled critical reactor STEK, 25:60159 (RCN-150)
RENSSELAER POLYTECHNIC INST., TROY, N.Y. DEPT. OF NUCLEAR SCIENCE.
  Formulation and application of analytic representations of fast reactor flux and importance spectra, 25:60211 (RPI-328-189)
RICE UNIV., HOUSTON, TEX.
  Prog. rpt. on nuclear physics, 3/71, 25:59692 (ORO-1316-99)
  Prog. rpt. on nuclear structure at intermediate energies, 3/71, 25:59693 (ORO-1316-100)
RIJKS INSTITUUT VOOR DE VOLKSGEZONDHEID, BILTHOVEN (NETHERLANDS). LABORATORIUM VOOR STRALINGSONDERZOEK.
  Gross radioactivity in airborne dust, 25:57575 (RA-42)
ROCHESTER GAS AND ELECTRIC CORP., N. Y.
  Robert Emmett Ginna Nuclear Power Plant, Unit No. 1. Technical supplement accompanying application to increase power, Amendment 3, 25:59942 (DOCKET-50244-81)
ROCHESTER UNIV., N. Y. DEPT. OF CHEMISTRY.
  Calculation of some isotope separation factors for chemical exchange, distillation, exchange distillation,

and absorption using UF/sub 6(g)/, 25:57528 (UR-3999-11)

ROME UNIV. (ITALY). ISTITUTO DI FISICA.
- Elementary solutions of Schrodinger equation for some time dependent interactions, 25:59207 (NP-19033)
- Exact ground state of some one-dimensional N-body systems with inverse (Coulomb-like) and inverse-square (centrifugal) pair potentials, 25:59840 (NP-19027)
- Remarks on inclusive experiments and high energy models, 25:59322 (NP-19024)

RUTHERFORD HIGH ENERGY LAB., CHILTON (ENGLAND).
- International survey of the operation of dc electrostatic particle separators, 25:59644 (RHEL/R-222)
- Simple ionization measuring device for bubble chamber pictures, 25:57825 (RPP/H-81)

S

SACRAMENTO MUNICIPAL UTILITY DISTRICT, CALIF.
- Rancho Seco Nuclear Generating Station, Unit 1. Statement why the construction permit should not be suspended pending completion of the NEPA environmental review, 25:59971 (DOCKET-50312-26)

SAINT MARY'S HOSPITAL, GRAND JUNCTION, COLO.
- Biology of carcinoma in situ of the lung, 25:60269 (COO-1826-17)

SANDIA LABS., ALBUQUERQUE, N. MEX.
- Detection of high explosives by capture gamma-ray techniques, 25:57866 (SC-RR-710450)
- Development of an electric manometer tester, 25:60286 (SC-DR-710418)
- Eye-controlled versus hand-controlled tracking, 25:60288 (SC-RR-710502)
- Ground motion predictions for Amchitka, 25:57602 (SC-RR-69-376)
- Operational amplifier models for computer-aided circuit analysis, 25:60289 (SC-RR-710628)
- Processing codes for group-averaged discrete ordinates cross-section tables, 25:59843 (SC-DR-710320)
- Program FGCD (user's and programmer's manual), 25:60287 (SC-M-710408)

SAXTON NUCLEAR EXPERIMENTAL CORP., PA.
- Saxton Reactor. Technical specifications, Change Report No. 25, 25:59937 (DOCKET-50146-94)
- Saxton Reactor. Technical specifications, Change Request No. 49, 25:59936 (DOCKET-50146-93)

SCRIPPS INSTITUTION OF OCEANOGRAPHY, LA JOLLA, CALIF.
- 1971 results for intercomparison of analytical methods for ^{137}Cs and ^{134}Cs used at Scripps with methods used at 56 other institutions, 25:57348 (TID-25777)
- Natural cesium in sea water, 25:57301 (TID-25776)

SKODA WORKS, PILSEN (CZECHOSLOVAKIA). NUCLEAR POWER CONSTRUCTION DEPT.
- Development of pressure vessel steels for Czechoslovak Nuclear Stations, 25:58216 (ZJE-106)
- Properties of zirconium alloys from the operation standpoint, 25:58217 (ZJE-107)
- Some remarks concerning zirconium alloy welding, 25:58188 (ZJE-110)

SOUTHAMPTON UNIV. (ENGLAND).
- Acoustically induced vibrations of slender rods in a cylindrical duct. I and II, 25:57621 (TRG-Report-2141)

SOUTHERN CALIFORNIA EDISON CO., LOS ANGELES.
- San Onofre Nuclear Generating Station, Unit 1. Technical specifications, Proposed Change No. 7 (revision), 25:59939 (DOCKET-50206-126)
- San Onofre Nuclear Generating Station, Unit 1. Technical specifications, Proposed Change No. 8, 25:59940 (DOCKET-50206-127)

SOUTHERN UNIV., BATON ROUGE, LA. DEPT. OF PHYSICS.
- Prog. rpt. on research in experimental and theoretical nuclear physics, annual, 7/15/71, 25:59841 (ORO-4119-1)

STANFORD UNIV., CALIF. INST. FOR PLASMA RESEARCH.
- Longitude distribution of solar flares, 25:58570 (N-71-14166)

STONE AND WEBSTER ENGINEERING CORP., BOSTON, MASS.
- Surry Power Station, Units 1 and 2. Sensitized stainless steel in pressurized water reactor applications, 25:59962 (DOCKET-50280-52)

T

TECHNISCHE HOCHSCHULE, AACHEN (WEST GERMANY).
- Determination of the anisotropy of the threshold energy for the production of Frenkel defects in Ta, 25:59125 (JUL-729-FF)

TECHNISCHE HOCHSCHULE, MUNICH (WEST GERMANY). INSTITUT FUER RADIOCHEMIE.
- Calculations for production of ^{231}Pa and ^{232}U by neutron irradiation from ^{230}Th and ^{232}Th mixtures in the reactor with various irradiation conditions, 25:57479 (BMBW-FBK-71-6)

TECHNISCHE UNIVERSITAET, MUNICH (WEST GERMANY).
- Simple technique of producing thin carbon films, 25:58346 (CONF-711002-, pp 144-6)

TELEDYNE ISOTOPES, WESTWOOD, N.J.
- ISIS: program for computerized fission data analysis, 25:59773 (AD-721481)

TENNESSEE VALLEY AUTHORITY, KNOXVILLE.
- Browns Ferry Nuclear Plant, Units 1, 2, and 3. State why the construction of the station should not be interrupted during prospective review period, 25:59950 (DOCKET-50259-27)
- Sequoyah Nuclear Plant, Units 1 and 2. Statement why construction permits should not be suspended pending completion of NEPA environmental review, 25:59977 (DOCKET-50327-20)

TEXAS UNIV., AUSTIN. CENTER FOR PARTICLE THEORY.
- Lower bound on lambda/sub +/ in K/sub 13/ decay, 25:59392 (ORO-3992-69)

THERMO ELECTRON CORP., WALTHAM, MASS.
- Thermionic performance of CVD tungsten emitters, 25:58839 (TEE-4125-5)

TOKYO UNIV. (JAPAN). INST. FOR NUCLEAR STUDY.
- Absolute measurement of alpha ray by a surface-barrier type silicon detector, 25:57794 (INS-TCH-5)
- Alpha-ray thickness gage. II, 25:57864 (INS-TL-112)
- Antiproton--proton charge exchange and elastic scattering at 232 MeV, 25:59266 (SJC-P-71-1)
- Optics of the 75 cm hydrogen bubble chamber. I, 25:57826 (SJC-T-71-3)

TOLEDO EDISON CO., OHIO.
- Davis--Besse Nuclear Power Station. Statement of reasons why construction permit should not be suspended pending environmental review, 25:59987 (DOCKET-50346-20)

TOULOUSE UNIV. (FRANCE). FACULTE DES SCIENCES.
- Secondary electron emission from germanium under electron bombardment, 25:58683 (FRNC-TH-49)

TUFTS UNIV., BOSTON, MASS. DEPT. OF PHYSIOLOGY.
- Prog. rpt. on transport and catabolism of proteins, techniques and mechanisms, final, 3/65--2/70, 25:60277 (NYO-3515-5)
- Uptake of ^{125}I labeled rat gamma globulin by intestinal epithelial cells in the neonatal rat, 25:60278 (NYO-3515-6)

U

UNION CARBIDE CORP., OAK RIDGE, TENN. COMPUTING TECHNOLOGY CENTER.
- Laboratory quality control computer program, 25:57611 (CTC-51)

UNION CARBIDE CORP., OAK RIDGE, TENN. Y-12 PLANT.
- Pyrolytic carbon infiltration studies, 25:58352 (Y-DA-2123(Rev.1))
- Scanning electron microscopy of fractures in welded structures, 25:58215 (Y-DA-4280)

UNITED KINGDOM ATOMIC ENERGY AUTHORITY, RISLEY (ENGLAND). AUTHORITY HEALTH AND SAFETY BRANCH.
- Review of fast reactor safety, 25:60113 (CONF-710922-3)

UNITED STATES-EURATOM FAST REACTOR EXCHANGE PROGRAM.
- Aqueous reprocessing of fast breeder fuel elements, 25:57518 (EURFNR-888)
- Fast Breeder Project. Fourth quarterly report 1970, 25:60010 (EURFNR-902)
- Inherent properties of the various primary circuit designs for sodium-cooled reactors, 25:60060 (EURFNR-904)
- Strategies for accelerating two-dimensional SN methods by coarse lattice technique, 25:60224 (EURFNR-899)

UNIVERSIDAD NACIONAL AUTONOMA DE MEXICO, MEXICO CITY. FACULTAD DE CIENCIAS.
- Dosimetry of ionizing radiation on Drosophila melanogaster, 25:57999 (NP-18944)
- Measurement of thicknesses of various materials using Si(Li) and surface barrier detectors, 25:57865 (NP-18941)

V

VIRGINIA ELECTRIC AND POWER CO., RICHMOND.
- North Anna Power Station, Units 1 and 2. Reasons why construction permits should not be suspended pending environmental review, 25:59985 (DOCKET-50338-32)
- Surry Power Station, Units No. 1 and No. 2. Final safety analysis report, amendment No. 26, 25:59960 (DOCKET-50280-50)

VIRGINIA UNIV., CHARLOTTESVILLE.
- Cross sections for (π^+,p) reactions on ^{9}Be, ^{12}C, and ^{16}O, 25:59710 (LA-DC-12781)
- New measurements of (π^+,2p) reactions on light nuclei, 25:59709 (LA-DC-12389)

W

WASHINGTON STATE UNIV., PULLMAN. RESEARCH DIV.
- Prog. rpt. on polymer grafting to inorganic substrates, annual, 2/1/70--1/31/71, 25:58416 (RLO-2098-2)

WASHINGTON UNIV., ST. LOUIS, MO. DEPT. OF CHEMISTRY.
- Prog. rpt. on reaction studies of hot silicon and germanium radicals, annual, 9/70--8/71, 25:57487 (COO-1713-25)

WASHINGTON UNIV., SEATTLE.
- Preparation of isotopic accelerator targets, 25:59636

  (CONF-711002-, pp 101-7)

WASHINGTON UNIV., SEATTLE. DEPT. OF MICROBIOLOGY.
  Characterization and fractionation of tobacco leaf transfer RNA, 25:60284 (RLO-2225-T-15-7)
  Prog. rpt. on aquatic myxobacteria, Columnaris and other fish pathogens, 1971, 25:60283 (RLO-2225-T-10-3)

WESTERN ENVIRONMENTAL RESEARCH LAB., LAS VEGAS, NEV.
  Environmental surveillance for Pewee 1, Experimental Plans II and III, November 21 and December 4, 1968. Final report, 25:60196 (SWRHL-87-r)
  Final report of off-site surveillance for the NRX-A6 reactor test series, 25:60195 (SWRHL-78-r)
  Off-site surveillance for Project Schooner, December 8, 1968, 25:57574 (PNE-524)
  Radionuclide studies with dairy cows following two Plowshare experiments, 25:57948 (SWRHL-85-r)

WESTINGHOUSE ELECTRIC CORP., PITTSBURGH, PA. MONROEVILLE NUCLEAR CENTER.
  Sensitized stainless steel in Westinghouse PWR nuclear steam supply systems, 25:59886 (WCAP-7735)

WISCONSIN ELECTRIC POWER CO., MILWAUKEE.
  Point Beach Nuclear Plant, Unit 1. Statement why operating license should not be suspended pending completion of NEPA environmental review, 25:59954 (DOCKET-50266-56)
  Point Beach Nuclear Plant, Unit No. 2. Emergency Core Cooling System, Appendix E, 25:59968 (DOCKET-50301-41)

WISCONSIN PUBLIC SERVICE CORP., GREEN BAY.
  Kewaunee Nuclear Power Plant. Statement supporting reasons why construction permit should not be suspended, 25:59970 (DOCKET-50305-26)

WISCONSIN UNIV., MADISON. DEPT. OF ZOOLOGY.
  Radiation induced DNA synthesis in the polytene chromosomes, 25:57951 (COO-1747-6)

WISCONSIN UNIV., MILWAUKEE. DEPT. OF GEOLOGICAL SCIENCES.
  Investigation into the potential seismological effects of the Cannikin Event, 25:57590 (COO-2138-4)

Z

ZENTRALSTELLE FUER ATOMKERNENERGIE-DOKUMENTATION, FRANKFURT AM MAIN (WEST GERMANY).
  Bibliographies in nuclear science and technology. Section C1, 25:57609 (AED-C-1-18)
  Bibliographies in nuclear science and technology. Section 14, 25:57368 (AED-C-14-5)
  Technology index for plasmaphysics research and fusion reactors, Vol. 5, No. 7, 1971, 25:58955

PERSONAL AUTHOR INDEX

Authors' names are indexed in the form appearing in the abstracted publication. Each entry under an author's name gives the publication title and the *NSA* volume and abstract numbers. Report numbers, where applicable, are given in parentheses at the end of the entry.

Because of problems involved in the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

Germanic	ä appears as	ae
Germanic	ö	oe
Germanic	ü	ue
Scandinavian	ø	oe

A

AARSNES, K., Variations in high-latitude proton trapping boundary, 25:58866
ABBATUCCI, J. S., Survival of Azotobacter chroococcum following γ irradiation and ibenzmethyzine treatment, 25:58156
ABBE, J. Ch., Formation of iodides in solid butane irradiated by I^+ ions, 25:57499
ABBOSOV, O., Neutron activation analysis of enriched isotopes of Eu, In, Ir, and Lu, 25:57391
ABBOUD, A., Cross sections for reactions ^{89}Y(n,n')/sup 89m/Y and ^{89}Y(n,2n)^{88}Y, 25:59768
ABDEL-KERIM, Fawzi M., Investigation of polymers formed in reactor irradiated benzene or toluene together with AlN, 25:57456
ABDINOV, O. B., Intranuclear cascades in light nuclei, 25:59265 (JINR-P2-5991)
ABDULIN, S. F., Increasing accuracy of Ta determination in ore-dressing products, 25:57327
ABDULLAEV, A. A., Radioactivation determination of Se, Te, and Au in natural waters, 25:57370
ABE, Ken, (γ,α) reaction experiment, 25:59734
ABE, Yasuhiro, Experimental fast reactor Joyo, 25:60175
ABEDIN-ZADEH, R., Evolution operator method and its application to problems of reactor theory, 25:60221
ABEL, F., Atomic displacements in He^+-irradiated Si and a Si--Ge alloy, 25:59136
ABKIN, A. D., Low-temperature radiation polymerization of acrolein in the solid state. I, 25:57531
ABRAMENKOV, A. D., Diffusion of substrate atoms into a surface film as indicated by the secondary ion--ion emission characteristics, 25:58266
ABRAMOV, A. A., Radiation effects in CdTe, 25:59161
ABRAMOVSKII, V. A., Inclusive processes at large transferred momenta, 25:59444
ABRAMOWICZ, M. A., Pressure inside a rotating star, 25:58486
ABRAMS, G. S., Evidence for a charge asymmetry on ω Dalitz plot, 25:59308
  Proposed method for a search for C violation via rho^0 interference in ω decay, 25:59552
ABRAMYAN, G. L., Lunar occultations of radio sources as a technique for investigating their angular structure, 25:58529
ABROSIMOV, N. K., Device for connecting the generator tube with the resonance system of a synchrocyclotron, 25:59649
ABROYAN, I. A., Effect of ion bombardment on semiconductors, 25:59173
ABU-BAKR, M. Y., Assay efficiency and response for cylindrical scintillation crystals and large-area gas counters applied to whole-body counting, 25:57772
ACHARYA, R., Lower bound on lambda/sub +/ in K/sub 13/ decay, 25:59392 (ORO-3992-69)
ACHTERMANN, E., Solar particle event of March 1970, 25:58892
ACKER, A., Orbital elements of the spectroscopic binaries HD 24733 and HD 861, 25:58442
ACKERMANN, N. J. Jr., Precision of shutdown margin measurements using the two-frequency reactor noise technique in an LMFBR, 25:60043
ACKERMANN, Norbert Joseph Jr., Neutron energy effects on reactor fluctuation spectra, 25:60238
ACTON, L. W., Helium-like line-emission coronal features, 25:58621
ADAIR, H. L., Target thickness and uniformity measurements using charged particles, 25:57863 (CONF-711002-, pp 307-20)
  Tritium-containing targets for high-yield neutron generators, 25:59670 (CONF-711002-, pp 166-80)
ADAM, J. C., Dissipative instability associated with electrons trapped in tokamak-type configurations, 25:59060 (CEA-CONF-1800)
ADAM, Waldemar, Mechanism of a rate-controlled cross-disproportionation between phenoxyl radicals, 25:57432
ADAMS, D. J., Cosmic x-ray astronomy, 25:58565
ADAMS, F., Large well-type GeLi detector for activation analysis, 25:57805
ADAMS, Kenneth G., Processing codes for group-averaged discrete ordinates cross-section tables, 25:59843 (SC-DR-710320)
ADAMS, M. F., Prog. rpt. on polymer grafting to inorganic substrates, annual, 2/1/70--1/31/71, 25:58416 (RLO-2098-2)
ADER, J. P., Some exact inequalities involving S and P waves and their derivatives for πK scattering, 25:59452
ADLER, D. B., Ambiguities in R-matrix parameters for interfering resonances with two fission channels, 25:59829 (COO-2022-11)
  Multilevel analysis of ^{235}U scattering cross section data, 25:59828 (COO-2022-10)
ADLER, F. T., Ambiguities in R-matrix parameters for interfering resonances with two fission channels, 25:59829 (COO-2022-11)
  Multilevel analysis of ^{235}U scattering cross section data, 25:59828 (COO-2022-10)
AFROSIMOV, V. V., Corpuscular plasma diagnostics, 25:58994
  Elementary atomic collision processes with change in charge states, 25:58743
AGEE, L. J., WIGL2, self-initializing version, 25:60209 (DUN-7538)
AHLUWALIA, H. S., Coupling functions applicable to the underground meson telescopes, 25:58822
AHMAD, I., Elastic scattering of 1 GeV protons from ^{12}C using the α-particle model, 25:59727
AIERS, M., Ion implantation of binary III--V semiconductors, 25:59168
AITKEN, D. K., Measurement of 10-μm flux from Crab Nebula, 25:58541
AITKEN, K. L., Cross sections for electron-impact ionization of multi-electron ions. II, 25:58769
  Cross sections for electron-impact ionization of multi-electron ions. I, 25:58774
AJELLO, Joseph M., Dissociative excitation of O_2 in vacuum ultraviolet by electron impact, 25:58758
  Emission cross sections of CO by electron impact in interval 1260 to 5000 A. I, 25:58759
  Emission cross sections of CO_2 by electron impact in interval 1260 to 4500 A. II, 25:58760
AKBAROV, U., Neutron activation determination of cobalt by nondestructive means, 25:57386
AKHIEZER, A. I., Scattering of γ quanta by nucleons in quark model, 25:59378
AKHMETOV, I. Z., Use of radioactive iodine in determining the functional activity of the thyroid gland of gerbils, 25:57915
AKIMOTO, Tadashi, Optimal power change of a reactor having internal feedback, 25:60241
AKINO, Norio, Some aspects on heat transfer and fluid dynamics of high temperature gas cooled reactor, 25:60076
AKOPOV, V. S., Evaluating the efficiency of radiographic quality control, 25:57696
  Optimal time of using a radioisotope source of radiation in nondestructive testing, 25:57697
AKRAMOV, M. B., Determination of tantalum in sphere by activation analysis, 25:57371
AKSENOV, V. V., Experimental determination of the electron concentration and temperature of an argon plasma jet by means of lasers, 25:58987
AKYUEZ, R. Oe., Energy displacement of dipole isodoublets,

25:59853
ALAKAEVA, L. A., Use of a Tb complex in determination of rare earth elements, 25:57317
ALBANY, H. J., Phonon scattering and induced energy levels in electron-irradiated Sb-doped Ge, 25:59134
ALBERNHE, F., Extraterrestrial γ-ray contribution between 0.7 and 4.5 MeV, 25:58832
AL'CHAGIROV, B. B., Surface energy and work function of the smooth faces of a metallic single crystal, 25:59194
ALCOCK, C. B., Icnic transport numbers of group IIa oxides under low oxygen potentials, 25:58379
ALCOUFFE, Raymond E., Effect of condensing the spatial mesh on the accuracy of fast breeder fuel-cycle analyses, 25:60100
ALEKSANDROV, A. F., Steady-state distribution of charged particles in the diffusion approach, 25:59048
ALEKSANDROV, L., Note on the determination of neutron diffusicn constants, 25:59687
ALEKSIC, B., Biological dosimetry methods, 25:58018
ALENIUS, G., Thermal neutron capture investigation of the ^{172}Yb and ^{174}Yb level structures, 25:59825
ALEXAN, Z., Determination of the concentration of ^{59}Fe in the coolant water of VVR-S reactor, 25:57346 (IFA-FR-82)
ALEXANDER, D. G., V--VO phase system, 25:58406
ALEXANDER, Gideon, Evaluation of low-energy ΣN interaction parameters, 25:59525
ALEXANDER, Peter, ISIS: program for computerized fission data analysis, 25:59773 (AD-721481)
ALEXANDER, R. M., Laboratory quality charge sensitive amplifier suitable for space applications, 25:57792
ALEXANDRE, Henri, Effect of x rays on DNA and RNA synthesis, 25:57944
ALFORD, W. L., Some (n,p) cross-sections of ^{46}Ti, ^{47}Ti, and ^{48}Ti, 25:59755
ALIMOV, A. D., Double scattering in Compton effect by light nuclei, 25:59703
ALLAART, K., Siegert's theorem and pairing factors for electric transition operators, 25:59864
ALLABERGENOV, B. R., Neutron activation determination of cobalt by nondestructive means, 25:57386
ALLCOCK, G. R., Rho--omega interference and the phase of the rho-propagator, 25:59348
ALLEMAND, R., Multiple proportional gas counter for the cartography of radioelements, 25:57774
ALLEN, N. L., Estimation and measurement of electron losses from avalanches in hydrogen, 25:59010
ALLER, Hugh D., Evolution at 8 GHz of linear polarization of 3C 279, 25:58556
ALLIBONE, T. E., Future of power generation in Great Britain, 25:57633
ALLKOFER, O. C., Electromagnetic interactions of high-energy cosmic-ray muons, 25:59246
ALLOIN, D., Spectrophotometric study of NGC 3627 galaxy nucleus, 25:58633
ALLWEIN, M., Manufacturing and in vivo application of miniaturized semiconductor detectors, 25:57745
ALM, Gerald V., Diffusion bonding. III, 25:58207
ALOUSH, A. A., Assay efficiency and response for cylindrical scintillation crystals and large-area gas counters applied to whole-body counting, 25:57772
ALPERT, B. D., Infrared bands of $H^{12}C^{15}N$, $D^{12}C^{15}N$, and $H^{13}C^{15}N$, 25:57421
ALTENHOFF, Wilhelm J., Aperture-synthesis observations of M17 and W49A at 2.695 GHz, 25:58557
ALTMAN, C., Height and frequency variation of penetrating and non-penetrating modes in the ionosphere, 25:58878
ALTON, G. D., Use of an electromagnetic isotope separator in preparing special research samples, 25:57650 (CONF-711002-, pp 10-20)
AL'TOVSKII, R. M., Anisotropy of self-diffusion of yttrium, 25:58240
ALTUKHOV, A. M., Bremsstrahlung hadron production in colliding electron--positron beams, 25:59375
AMANN, J. F., Symmetry energy for collective dipole excitation, 25:59742
AMANO, Hiroshi, Preparation of /sup 99m/Tc by direct adsorption from organic solution, 25:57483
AMARI, Hiroko, Real time dose distribution display by digital computer, 25:58078
AMATO, J., Cross sections for (π^+,p) reactions on ^{9}Be, ^{12}C, and ^{16}O, 25:59710 (LA-DC-12781)
 New measurements of $(\pi^+,2p)$ reactions on light nuclei, 25:59709 (LA-DC-12389)
AMBARYAN, S. S., Steady-state distribution of charged particles in the diffusion approach, 25:59048
AMBLER, J. F. R., Attack polishing of metals and ceramics, 25:58353
AMBROK, G. S., Radial distribution of radiation intensity in axisymmetric dense plasma, 25:59036
AMBROZ, P., Planetary influences on large-scale distribution of solar activity, 25:58611
AMEEN, N., Measurements of the total neutron cross section of praseodymium between 1 and 18 MeV, 25:59811
AMELINCKX, S., Substructure of γ-vanadium suboxide resulting from long range ordering of oxygen, 25:58392
AMERESEKERE, R. V. W. E., Histopathological studies on irradiated and chemosterilized beet leafhoppers, Circulifer tenellus, 25:58093
AMMANN, Arthur Carl, Interaction of K^- mesons on deuterium at 4.5 GeV/c, 25:59280
AMMERMANN, Dieter, Development of macronuclei of Stylonychia mytilus and Euplotes aediculatus, 25:58096
AMNUEL, P. R., Identification of cosmic x-ray sources, 25:58530
AMUNDSEN, R., Variations in high-latitude proton trapping boundary, 25:58866
ANANAD, S. P. S., Rapidly rotating supermassive stars in approximation to general relativity, 25:58496
ANAND, S. P. S., Rapidly rotating polytropes in post-Newtonian approximation to general relativity, 25:58495
 Structure of rapidly rotating relaxed globular clusters, 25:58494
ANBAR, M., Effect of thallous ions on the yields of hydrogen and hydrogen peroxide in radiolyzed aqueous solutions, 25:57472
ANDERS, Annerose, X ray-induced mutations of genetically-determined melanoma system of Xiphophorin fish, 25:57957
ANDERS, Edward, Origin of organic matter in early solar system. III, 25:58575
 Origin of organic matter in early solar system. IV, 25:58576
ANDERS, F., X ray-induced mutations of genetically-determined melanoma system of Xiphophorin fish, 25:57957
ANDERSEN, H. H., Low-temperature irradiation facility for heavy-ion radiation damage studies of metals, 25:57620 (RISO-204)
ANDERSON, E. W., System for multiparameter pulse height analysis with repeated use of a single, fast ADC, 25:59668
ANDERSON, John D., Spectra of fast neutrons from water pulsed with 14-MeV neutrons, 25:59674
ANDERSON, Kurt S., Interpretation of the Hα profile of Seyfert galaxy NGC 5548, 25:58655
ANDERSON, T. T., High-temperature acoustic sensors for boiling detection, 25:60090
ANDERSSON, Sigfrid, Cylindrical pressure vessel, 25:60070
ANDERSSON, T. L., Integral measurement of fission-product reactivity worths in some fast reactor spectra, 25:60034 (AE-428)
ANDERSSON-LINDSTROEM, G., Current pulse shapes of semiconductor detectors, measured with an averaging technique, 25:57737
ANDREEV, A. F., Surface second sound in liquid helium, 25:58931
ANDREEV, A. V., Use of fast 14-MeV neutrons for determination of O in pure materials, 25:57376
ANDREEV, S. I., Plasma temperature determinations near a dielectric surface, 25:58985
ANDREWS, Harry N., Nuclear reactor control device, 25:60244
ANDREWS, Vernon E., Design and construction of a four-decade digital log ratemeter, 25:57893
ANDRZEJ, Ignacy, Influence of uv radiation on pigeon erythrocytes, 25:58113
ANGEL, J. R. P., Oscillation in optical and x-ray flux from Scorpius X-1, 25:58535
 Oscillations in x-ray flux from Scorpius X-1, 25:58536
ANGER, C. D., Passage of auroral x rays through the atmosphere, 25:58868
ANGERMAN, C. L., Prog. rpt. on ^{60}Co power and heat sources, 4--6/71, 25:57654 (DP-1279)
ANGLIN, F. M., Discrimination of earthquakes and explosions using short period seismic array data, 25:57600
ANICIN, B. A., Guided electron plasma waves, 25:59100
ANIMALU, A. O. E., Bound states and mass spectra of hadrons in the quark model, 25:59426
ANISIMOV, A. I., Microwave absorption by a plasma at the upper hybrid frequency, 25:59091
ANISOVICH, V. V., Structure of scattering amplitudes and inelastic process amplitudes in pre-asymptotic region, 25:59497
ANNA, T. L., Computer controlled instrumentation for plutonium measurement, 25:57897
ANNO, Tosinobu, Significance of Pariser method for evaluation of one-center electron repulsion integral, 25:58808
ANOKHIN, A. S., Resistance of lupine to x radiation, 25:58149
ANOKHINA, V. S., Resistance of lupine to x radiation, 25:58149
ANSORGE, V., Magnetic transition points in U_3Bi_4 and UGa_2, 25:59190
ANTHONY, M. C., Isotope exchange and thermal annealing of recoil damage in trisoxinatocobalt(III), 25:57493
ANTICH, Pietro Paolo, K^-d interactions at 12.6 GeV/c, 25:59283
ANTIPOVA, L. I., Hydrogen lines in envelope of Nova Herculis 1934, 25:58426
ANTOKU, Shigetoshi, Dosimetry of x-rays, gamma-rays, and neutrons with ferrous sulfate solution, 25:57862
ANTONOV, A. V., Spectrographic method for determining main components in alloys based on cobalt, 25:57313
ANTONOV, V. A., Comparison and analysis of the parameters of clinical whole-body spectrometers, 25:57823
ANTONOVA, V. A., Comparative behavior of ^{89}Sr and ^{140}Ba in skin, 25:57917
ANZER, U., Energy balance in cool quiescent prominences, 25:58603
AOKI, Toshio, Characteristics and design bases of charcoal

XUM

filter, 25:60088
AOKI, Tsuyoshi, Design of safety valves and the like for BWR-type power stations, 25:57637
AONO, Osamu, Relaxation of difference between ion and electron temperatures in a plasma, 25:59028
APPARAO, Krishna M. V., Transient gamma-ray sources, 25:58550
ARAI, Masahiko, Lower bound on amplitudes below threshold for $\pi^0\pi^0$ scattering, 25:59459
ARDALAN, Farhad, Decomposition SO(p,1) is contained in SO(p-1,1) for most degenerate representations, 25:59535
  Spinor hyperplane field theory, 25:59553
ARENHOVEL, H., Effect of baryon resonance admixtures on elastic electron deuteron scattering, 25:59367
ARGUE, A. N., Accurate radio and optical positions of 3C 273B, 25:58566
ARIFOV, U. A., Charge exchange and transition reactions of a hydrogen atom during collisions of argon ions with water molecules, 25:57460
ARIGA, Seiich, Ohmic heating of plasma in Heliotron C magnetic field. I, 25:58963
ARIGA, Seiichi, Effect of electron and ion drifts on double probes, 25:58981
ARIMA, A., Reaction ^{12}C(^{14}N,^{6}Li)^{20}Ne and structure of upper K = 0^+ bands, 25:59743
ARISKIN, V. I., Ionized-hydrogen distribution in the Galaxy, 25:58528
ARITOMI, Noriyoshi, Effects of grain size and carbon content on the ductility of recrystallized molybdenum wire, 25:58269
ARIZAN, D., Radicprotective effect of ethylene glycol on bacteria, 25:58157
ARMITAGE. A. C., Nuclear economics and change, 25:59920
ARMSTRONG, Clarence A., Log of Hydrologic Test Well 1, Tatum dome area, Lamar County, Mississippi. Dribble-6, 25:57562 (USGS-474-110)
  Log of Hydrclogic Test Well 2, Tatum dome area, Lamar County, Mississippi. Dribble-7, 25:57563 (USGS-474-111)
ARMSTRONG, James C., Ordinary-mode electromagnetic instability in colliding plasma streams, 25:59065
ARMSTRONG, L. L., Group properties of radial wave functions, 25:58786
ARNELL, S. E., Thermal neutron capture investigation of the ^{172}Yb and ^{174}Yb level structures, 25:59825
ARNO, James A., Spectrophotometric determination of Ru with 3,4-diamincbenzoic acid, 25:57325
ARNOLD, E. D., Neutron-capture-γ ray spectrum calculations for materials for possible use in a ^{252}Cf neutron activaticn facility, 25:57796 (ORNL-TM-3457)
ARNOLD, G. W., Preferential etching of ion-bombarded GaAs, 25:59141
ARNOLD, W. D., Radioactive contamination of copper recovered from ore fractured with nuclear explosions, 25:57523 (ORNL-4677)
ARSENAULT, R. J., Dynamic dislocation pile-up in neutron-irradiated metals, 25:58337
  Low temperature deformation characteristics of neutron irradiated vanadium--titanium alloys, 25:58339
ARTHUR, E., Cross sections for (π^+,p) reactions on ^{9}Be, ^{12}C, and ^{16}O, 25:59710 (LA-DC-12781)
  New measurements of (π^+,2p) reactions on light nuclei, 25:59709 (LA-DC-12389)
ASAY, James Russell, Effects of point defects on elastic precursor decay in lithium fluoride, 25:59126
ASBROECK, Van, GBR fuel pin technology, 25:58410 (BLG-456)
ASHBY, Neil, Statistical atom model based on a local Coulomb approximation, 25:58815
ASHENHURST, Robert L., Prog. rpt., 5/71, 25:60270 (COO-2094-7)
  Prog. rpt., 8/71, 25:60271 (COO-2094-8)
ASHLEY, James Wilfred, Power plants, 25:60141
ASHTON, F., Electromagnetic interactions of cosmic-ray muons at large zenith angles at sea level, 25:59343
ASKEW, J. R., Numerical methods applied to problems of neutron transport, 25:59664
ASPREY, L. B., New high-temperature phase of protactinium metal, 25:58291
ASTRAKHAN, B. V., Comparison of calculated and experimental dose fields of a proton beam, 25:58023
ATANASOVA, B., Rapid photometric determination of selenium in tellurium with different purity (up to 99.99 percent), 25:57323
ATARASHI, Masaru, Cascade process in mesic atoms, 25:58724
ATHERTON, David R., Photon detector utilizing a well-type scintillation crystal, 25:57759
ATTIX, F. H., Luminescence and exoelectron dosimetry in personnel monitoring, 25:57833
AUER, L. H., Stellar atmospheres problem, 25:58469
AUERBACH, N., Isobaric mass equation in A = 4n + 1 nuclei, 25:59882
  Isovector monopole state and Coulomb displacement energies, 25:59871
AUERBACH, T., Neutron flux in cells of finite, square lattices, 25:60228
AUJARD, Colette, Multiplication of cultured cells and their survival after ultraviolet irradiation, 25:58087
AUST, C., Floccule theory and planetary formation, 25:58586
AUXIER, J. A., Outcry over exposure guidelines, 25:60128
AVAKYAN, B. P., Uv radiation and ultrasonic waves in treating wine microflora, 25:58158
AVIGNANT, Daniel, TlF--UF$_4$ system, 25:58418
AVRETT, Eugene H., Radiative transfer in two-component stellar atmospheres, 25:58468
  Solution of non-LTE transfer problems, 25:58467
AXFORD, W. I., Dynamical behavior of thermal protons in the midlatitude ionosphere and magnetosphere, 25:58867
  Interaction between interstellar helium and the solar wind, 25:58855
AYRE, C. A., Absolute intensities of cosmic ray muons above 3.48 and 7.12 GeV/c, 25:58826
AYRES, Gilbert H., Spectrophotometric determination of Ru with 3,4-diaminobenzoic acid, 25:57325
AZIMOV, S. A., Coherent interactions of pions with nuclear emulsion at energies of 17 and 45 GeV, 25:59313
  Inelastic pion--nucleon interactions with high multiplicity and the one-pion exchange model, 25:59496
AZIZOV, U. V., Thermoemissive properties of a spherical monocrystal of tantalum, 25:59177
AZUMA, R. E., K/sup π/ = 1^+ rotational band in ^{18}F, 25:59715
AZUMA, Shuko, Generalization of quantum field theory on the basis of function manifold, 25:59559

B

BABAEV, A., Determination of tantalum in sphere by activation analysis, 25:57371
BABINET, Gonzague, First unit of Saint-Laurent-des-Faux power plant: general characteristics, power run-up, 25:59896
BADEWITZ, R. C., Application of dual diffractive model to reaction $\pi^+d \to d\pi^+\pi^+\pi^-$ at 13 GeV/c, 25:59480
BADIELLO, R., Survival of E. coli B/r after x irradiation, 25:58155
BADIER, J., Study of anti pp annihilation at 2.5 GeV/c with production of two kaons in final state, 25:59272
BADR, F. M., Effect of x-irradiation on mitotic activity of bone marrow cells of laboratory and wild rats, 25:58116
BADR, Ragaa S., Effect of x-irradiation on mitotic activity of bone marrow cells of laboratory and wild rats, 25:58116
BAER, G., Statistical evaluation of image in scintigraphy, 25:58067
BAERTSCH, R. D., Progress in the fabrication of γ-ray detectors from high purity germanium, 25:57814
BAGLAN, R. J., Threshold photoneutrons and photon doorways, 25:59784 (UCRL-73336)
BAGLEY, K. Q., Density changes in cladding materials irradiated in DFR, 25:58306
  Fast neutron induced voidage in non-fissile metals and alloys, 25:58305
BAGLIN, C., Heavy liquid bubble chamber analysis of eta^0 neutral decay modes, 25:59244
BAGRETSOV, V. F., Purification of the coolant water by distillation, 25:60064
BAGROV, V. G., Radiation of scalar particles in field of two traveling electromagnetic waves moving toward each other, 25:59226
BAHCALL, J. N., Ultradense matter, 25:58432
BAHETHI, O. P., T matrix for Hulthen potential, 25:59631
BAILEY, D. M., Radiation damage to the crystalline structure of a glass-forming chalcogenide, 25:58419
BAILLON, P., Baryon decay rates within SU(3), 25:59491
BAIRD, K. M., Determination of frequency of 10-cm radio line of CH, 25:58700
BAIRSTOW, R., Simple ionization measuring device for bubble chamber pictures, 25:57825 (RPP/H-81)
BAKER, C., Chemical etchant for (PuTh)O$_2$ ceramic microscopy, 25:58354
  Method for producing thin foils from graphitic materials for transmission electron microscopy, 25:58350 (RD/B/N-2020)
BAKER, George A. Jr., Singularity structure of the perturbation series for the ground-state energy of a many-fermion system, 25:59233
BAKESIGAKI, A., Breaking of scale invariance, Regge trajectories, and dyons, 25:59430
BALAKHANOV, V. Ya., Edge effects in excitation of magnetoacoustic waves in plasma, 25:59089
BALAKRISHNAN, M. S., Stability constants of uranyl ion with mixed carboxylic acids, 25:57402
BALASHOV, V. A., Effect of crystal structure disorder of BN on its sintering, 25:58359
BALASHOV, V. V., Unified description of inelastic and quasielastic electron scattering from nuclei, 25:59869
BAL'BUTSEV, E. B., Calculation of neutron equilibrium pairing in spherical single closed shell nuclei, 25:59833 (JINR-E4-5907)
BALDINGER, E., Channels on surfaces of Ge(Li)-diodes and their influence on x-ray and electron spectra, 25:57797
BALL, G. C., Charge-exchange and/or knockout spectator poles in reaction D(^{3}He,tp)p, 25:59694
BALL, John A., Radiofrequency detection of an anomalous interstellar recombination line, 25:58563
BALL, R. M., Automatic-ranging picoammeter for reactor control and protection, 25:57899
BALLESTRERO, A., Multiparticle production model with charge conservation, 25:59512

BALLOT, J. L., Calculation of the pion--nucleus optical potental, 25:59516
BALOSHIN, O. N., Investigation of reaction $\pi^-p \to pX^-$ at momentum of 3.25 GeV/c with high momentum transfer, 25:59312
BALTAY, C., Precision measurement of lifetime and decay branching ratio of Λ^0 hyperon, 25:59260
BAL'TER, S. A., Comparison of calculated and experimental dose fields of a proton beam, 25:58023
BAMMERT, K., Emergency cooling system for a nuclear power gas turbine, 25:60110
  Gas turbine for a nuclear power plant, 25:60145
BAMPTON, P. F., Evaluation of average ν for ^{238}U, 25:59775 (AWRE-O-44/71)
BANCEL, Daniel, Cauchy problem for the nonlinear boltzmann equation in general relativity, 25:59594
BANDO, Hiroharu, Reaction matrix theory for cluster states in light nuclei. II, 25:59724
BANKS, P. M., Dynamical behavior of thermal protons in the midlatitude ionosphere and magnetosphere, 25:58867
BARAK, J., ^{153}Eu indirect spin--spin interaction, 25:59200
BARAKAT, M. F., Investigation of polymers formed in reactor irradiated benzene or toluene together with AlN, 25:57456
BARANNIK, P. I., Trace element contents and natural radioactivity of foods in some districts of Kiev region, 25:57987
BARASHENKOV, V. S., Interaction of high-energy radiation with matter, 25:59508 (ORNL-tr-2514)
  Intranuclear cascades in light nuclei, 25:59265 (JINR-P2-5991)
  Statistical reconstruction of inelastic π-N and N-N interactions in the superhigh energy region, 25:59472 (JINR-P2-6022)
BARAT, F., Transient species in the pulse radiolysis of periodate ion in neutral aqueous solutions, 25:57466
BARATOV, D. G., Influence of high-frequency potential of a toroidal electric field on the trapping of charged particles in a closed magnetic trap, 25:58976
BARBASON, H., Repair of radiolesions responsible for the formation of micronuclei and ana-telophase bridges in the rat liver, 25:58130
BARBER, W. H., Activation analysis of sodium and potassium in solid propellants, 25:57384
BARCI, V., Lifetime measurements in sd shell nuclei. VII, 25:59751
BARDIN, D. Yu., $\pi^+ \to e^+(\mu^+)\nu e^+e^-$ decays, 25:59412
BARDIN, T. T., Comparison of analogous $\Delta T = 0$ β- and γ-ray decays in nuclear 2s--1d shell, 25:59844
BARDIN, V. V., Potentiometric determination of microconcentrations of iodide ions, 25:57314
BARGER, V., Complex Regge poles, 25:59434
  Deductions from new $\pi^-p \to \pi^0n$ data at large momentum transfers, 25:59289
BARINOV, Y. V., Effect of neutron and alpha-particle irradiation upon physical properties of α-SiC, 25:59154
BARISIC, S., Periodic modes and structural transition in Labbe--Friedel model of A_3B compounds, 25:58947
BARKER, A. A., Effective potentials between the components of a hydrogeneous plasma, 25:59042
BARKER, F. C., Magnetic analysis of reactions ^{7}Li(^{3}He,d)^{8}Be and ^{7}Li(^{3}He,t)^{7}Be, 25:59731
BARKER, R. W., Biaxial stress rupture properties of annealed 316 stainless steel after EBR-II irradiation, 25:58297 (HEDL-TME-71-72)
BARKOV, L. M., Magnetic moment of Λ^0 hyperon, 25:59294
BARLOUTAUD, R., Experimental study of two-body and quasi-two-body reactions in K^-n interactions at 3 GeV/c, 25:59291
BARMAWI, M., Parity rule and helicity conservation in rho photoproduction, 25:59384
BARNES, P., New measurements of $(\pi^+,2p)$ reactions on light nuclei, 25:59709 (LA-DC-12389)
BARNETT, M., Variations in the relationships between total ^{59}Fe uptake and heme and nonheme fractions of spleen and bone marrow in irradiated mice and mouse radiation chimeras, 25:58119
BARNHAM, K. W. J., Evidence for a charge asymmetry on ω Dalitz plot, 25:59308
BAROUCH, E., Solar longitude dependence of proton-event delay time, 25:58612
BARR, R., Effect of Earth's magnetic field on propagation of elf and vlf radio waves, 25:58873
BARROS, Antonio A. S., Thermodynamic behavior of the ''multiflash'' evaporator, 25:57616 (LFEN-NI.-54-a)
BARROSO, A., Fluorescence, Auger, and Coster--Kronig L/sub II/ subshell yields of Th, 25:58719
BARSHAY, S., Suggestion concerning the present anomaly in rate $(K_2 \to \mu^+\mu^-)$/rate $(K_2 \to 2\gamma)$, 25:59419
BARSTON, E. M., Eigenvalue problems for Lagrangian systems. V, 25:59052
BARSUKOVA, K. V., Isolation of berkelium on a zirconium phosphate--silicate sorbent, 25:57530
BARTA, J., Activated sintering, 25:58200
BARTH, F., Release of gaseous fission products from carbons, 25:58367 (EUR-4327)
BARTHELEMY, Pierre, α-ray heat source, suitable for use in a cardiac pacemaker, 25:57668
BARTOLI, B., High-energy electron--positron elastic scattering, 25:59250
  Mulitparticle production from e^+e^- interactions as high energy, 25:59251
BARTOLOME, Z. M., Thermoluminescence dosimetry studies, 25:57845
BARTON, H. R. Jr., Application of dual diffractive model to reaction $\pi^+d \to d\pi^+\pi^+\pi^-$ at 13 GeV/c, 25:59480
BARTON, P. J., Effect of stress during irradiation on void formation in nickel, 25:58308
BARTSCH, J., g-meson, 25:59298
  $\pi\pi$ scattering effects in π^+p interactions at 8 GeV/c, 25:59296
BARUCH, P., Atomic displacements in He$^+$-irradiated Si and a Si--Ge alloy, 25:59136
BARUT, A. O., Atoms with magnetic charges as models of hadrons, 25:59447
BARYSAGLEBSKI, L. A., Theory of structural corrections in pair conversion coefficients in M1 transitions of nuclei, 25:59861
BARYSHEVSKII, V. G., Scattering of light by a flow of electrons through a crystal, 25:59228
BASALAEVA, L. N., Coprecipitation of radium with a prototype of the bone mineral calcium hydroxylapatite, 25:57418
BASHEV, V. F., Fine structure parameters of Al--W, Al--Mo, and Al--Mn alloys obtained at high cooling rates, 25:58284
BASILE, M., Evidence for decay mode $X^0 \to \gamma\gamma$ and determination of branching ratio $X^0 \to \gamma\gamma/X^0 \to$ total, 25:59290
BASILE, P., Determination of low-energy π--π phase shifts and form factors in K/sub e4/$^+$ decay, 25:59263
BASOV, Nilolai, Laser light for fusion fire, 25:59057
BASOVA, E. S., Coherent interactions of pions with nuclear emulsion at energies of 17 and 45 GeV, 25:59313
BASSETTO, A., Two-particle correlations in high energy production experiments, 25:59436
BASU, Debabrata, Formal equivalence of H atom and harmonic oscillator and factorization of Bethe--Salpeter equations, 25:59227
BAT, G. A., Temperature effect in 20 to 250°C range for certain, strictly regular, heterogeneous, U--H_2O critical assemblies, 25:60161
BATTEN, Alan H., Two new chapters in story of U Cephei. II, 25:58435
BATTISTA, A. J., Method for the design of near-optimum filters for nuclear signal transmission systems, 25:57892
BAUCHINGER, M., Relevance of chromosome aberration yields for biological dosimetry after low-level occupational irradiation, 25:58015
BAUM, Eric, Theory of cooled spherical electrostatic probe, 25:58982
BAURMASH, L., Analysis of aerosol behavior for FFTF hypothetical accidents, 25:60148 (AI-69-Memo-95)
BAYAR, B., Fast thermochemical methods of separation of radioactive elements. I, 25:57480 (JINR-P6-5955)
BAYBARZ, R. D., Electron-transfer and f $\to$ d absorption bands of some lanthanide and actinide complexes and standard (III--IV) oxidation potentials for each member of lanthanide and actinide series, 25:57437
BAYER, Kenneth C., Earthquakes on and around Nevada Test Site, 1950--71, 25:57589 (CGS-746-12)
BAZ, A. I., Scattering, reactions, and disintegrations in nonrelativistic mechanics, 25:59612
BAZHANOV, E. B., Formation of braking radiation beam of medical betatron, 25:59651
BAZILEVSKII, L. N., Hardness of alloys in the magnesium--cadmium and tellurium--bismuth systems, 25:58253
BAZIN, H., Serum concentrations of immunoglobulin in pigs after exposure to γ ray, 25:58104
BAZZARRI, S., Radiotoxicological analyses used at CNEN, 25:57347 (RT/PROT-(71)9)
BEAVER, J. E., Failure of aluminum tubing in the ORNL 86-inch cyclotron, 25:59643 (ORNL-TM-3523)
BECHTEL, F. K., Eye-controlled versus hand-controlled tracking, 25:60288 (SC-RR-710502)
BECK, James Noble, Radioactive cerium fallout and hot particles in the atmosphere, 25:57578
BECKA, J., Development of pressure vessel steels for Czechoslovak Nuclear Stations, 25:58216 (ZJE-106)
BECKER, J. A., Comparison of analogous $\Delta T = 0$ β- and γ-ray decays in nuclear 2s--1d shell, 25:59844
BECKER, K., New exoelectron dosimeters, 25:57835
BECKER, Martin, Formulation and application of analytic representations of fast reactor flux and importance spectra, 25:60211 (RPI-328-189)
BECKER, Richard A., Thermionic converter cells for nuclear reactor, 25:60197
BECKER, Richard L., Factorization and folded diagrams in Goldstone linked-cluster series, 25:59865
BECKLEY, Bruce B., Instrumentation at Connecticut Yankee and Maine Yankee atomic power stations, 25:59899
BEDBENOV, V. B., Experimental studies of power increase in In--Ga radiation loops, 25:60170
BEDE, Gabor, Some of the problems and the present world situation of atomic power plant construction, 25:59887
BEDER, Douglas S., Calculations of low energy πd reactions, 25:59484
BEDEWI, F. El., Coupling between primary and secondary cosmic-ray muon variations at high energies, 25:58827
BEDFORD, A. J., Hexagonal networks of dislocations in α-Zr, 25:58288

BEDROSIAN, P. H., Improved photographic leak test system for sealed sources of ^{226}Ra, 25:57707
BEERE, W., Nucleation of atomic steps on inert gas bubbles intersected by dislocations, 25:58214 (RD/B/N-2023)
BEFRE, J. L., Phenix reactor, 25:60077
BEGENT, H. H., Transmission in the 1980's, 25:60109
BEIGMAN, I. L., Magnetic-dipole transition operator with an accuracy to α^2 for atoms with one or two electrons, 25:58803
BEKES, E., Calculations of dose fractions of slow, intermediate, and fast neutrons behind different shields, as well as readings of selected dosimeters, 25:57858
BELGRAVE, E., Effects of thermal neutron capture in platinum acetylacetonate, 25:57489
BELL, Myron H., Nuclear power operations Deep Freeze 70--71, 25:60206
BELL, Robert S., Plan ahead for decontamination, 25:60099
BELL, W. L., Dislocation contrast at high voltages, 25:60292 (UCRL-20700)
BELLENGER, D., Photoproduction of π^0's from neutrons at 4 GeV, 25:59243
BELLER, M., Experimental work in the Brookhaven Chemonuclear In-Pile Research Loop, 25:57610 (BNL-50293)
BELLIN, Andre, First unit of Saint-Laurent-des-Faux power plant: general characteristics, power run-up, 25:59896
BELLONI, J., Radiolytic formation of long-lived ammoniated electrons, 25:57477
BELONUCHKINA, I. I., Trajectories of charged particles in magnetic and electric fields with discrete potential distribution, 25:59231
BELOTE, T. A., Reaction ^{12}C(^{14}N,^{6}Li)^{20}Ne and structure of upper K = 0^+ bands, 25:59743
BELOUSOVA, L. E., Inherent magnetic field in the positive column, 25:59038
BELOZEROV, V. G., Use of fission chambers in water-cooled reactors, 25:60046
BELYAEV, V. A., Merging beam technique to study ion--atom collision processes, 25:58744
BELYAEV, Yu. I., Reduction of uranyl ion by Ti(III) in nonaqueous media, 25:57415
BENDER, Carl M., Covariant derivatives of infinite-dimensional fields, 25:59582
BENDER, I., nanti p annihilation at rest in a dual model for $\pi\pi$Nanti N-five point function, 25:59465
BENDER, J. H., Automated camera for hot cell metallography, 25:57627
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BENEDETTI, G. R., Computer program for determination of isodose curves for electron energies from 5 to 42 MeV, 25:58009
  Computer programs for irradiation planning in high-energy therapy, 25:58008
  Computer programs for irradiation planning in high-energy therapy, 25:58020
  Computer programs for irradiation planning in high-energy therapy, 25:58021
BENES, J., Dosimetric checking of ^{90}Sr in biological chain, 25:57366
BENEZECH, G., Detection and alarm system for accidential nuclear excursions, 25:57780
BENNETT, L. R., ^{111}In: new radioisotope for cysternoscintillography, 25:58052
BENNETT, Leonard L., Evaluation of plutonium use in high-temperature gas-cooled reactors, 25:60097 (ORNL-TM-3525)
BENNETT, Robert K., Scanning electron microscopy of fractures in welded structures, 25:58215 (Y-DA-4280)
BENOIST, E., Phenix reactor, 25:60087
BENOIT-CATTIN, Pierre, Excitation of auto-ionization levels of He by collision with a heavy particle, 25:58779
BENTLEY, R. F., New (p,n) reaction studies at Ep = 23 MeV, 25:59789
BENZI, V., SASSI: FORTRAN program for calculation of neutron scattering from a spherical optical potential, 25:59842 (RT/FI-(71)6)
BERANGER, G., Does oxidation of Zr obey Wagner's theory, 25:58254
BERANOVA, H., Partition chromatography of uranium and fission products on porous styrene-divinylbenzene copolymer swollen in the solution of tributylphosphate. III, 25:57527 (UJV-2557-Ch)
BERCAW, R. W., Coincidence study of reaction ^{2}H(d,dp)n, 25:59699
BERENDS-VAN ABKOUDE, E. R., Induction of mutations in bacteriophage by ionizing radiation, 25:57971
BEREZIN, A. K., Influence of longitudinal density gradient on the transformation and emission of transverse waves from a beam-plasma discharge, 25:59104
BEREZINA, G. P., Influence of longitudinal density gradient on the transformation and emission of transverse waves from a beam-plasma discharge, 25:59104
BERG, G., Gamma energy resolution of multiplying detectors, 25:57748
BERGEMANN, W., Cause and reduction of contamination of the primary coolant loop in nuclear power plants with pressurized-water reactors, 25:60068
BERGENLID, U., Some observations of thermal release of helium from irradiated nickel, 25:58335
BERGER, F. P., Air flow through concentric ducts separated by a porous pipe, 25:57645
BERGERE, R., ^{208}Pb(γ,n)^{207}Pb reaction near threshold, 25:59778 (JAERI-Memo-4520)
BERGERON, J., Optical line spectrum of a gas heated by hard uv radiation or energetic particles, 25:58629
BERGGREN, R. G., Tensile and impact properties of thick-section plate and weldments, 25:58218
BERGMANN, Helmar, Isomer ratios for (n,2n) reactions in range of mass numbers between 70 and 90, 25:59766
BERGSTROEM, I., E2 core polarization by neutrons in (i/sub 13/2/)$^{-2}$ configuration in ^{206}Pb, 25:59818
  Evidence for high-spin core-excited states in ^{210}Po, 25:59817
BERKHUIJSEN, Elly M., Are the galactic loops supernova reminants, 25:58628
BERKOV, A. V., Angular and momentum distributions of μ^+ mesons from W^+-boson decay in reaction ν/sub μ/ + Z → μ^- + Z + W^+, 25:59413
  Angular and momentum distributions of μ^+ mesons in reactions of direct production of leptonic pairs by neutrino beam in electromagnetic field of nuclei and nucleons, 25:59415
BERMAN, B. L., Threshold photoneutrons and photon doorways, 25:59784 (UCRL-73336)
BERMAN, I. V., Superconductivity of gallium arsenide at high pressures, 25:58944
BERMANN, F., Dosimetric applications of EPR measurements of free radicals formed in amino acids, 25:57852
  LiF radiothermoluminescent dosimeters which can be reused without regeneration, 25:57848
BERNAS, R., Cross sections for the production of beryllium isotopes from the 880 MeV alpha-particle bombardment of carbon, 25:59733
BERNHARD, Horst, Generator substance for producing radioactive /sup 137m/Ba, 25:57484
BERNOVSKAYA, R. N., Influence of iron on the physicochemical state of radioelements in sea water, 25:57410
BERNSTEIN, G. J., Chemical Engineering Division.fuel cycle technology quarterly report, January--March 1971, 25:57507 (ANL-7799)
  Development of a mixer-settler for liquid metal-salt systems, 25:57508 (ANL-7810)
BERNT, H., Determination of carrier-mobility and lifetime in p--i--n detectors from the response to modulated light, 25:57738
BERRY, John T., Lubrication aspects of deep drawing of stainless steel, Ti, and Ni-base alloys at elevated temperatures, 25:58195
BERRY, P. F., Study of particulate heterogeneity effects in radioisotope x-ray spectrometry, 25:57300 (ORO-3847-2)
BERTAUD, J. L., E-22 French experiment aboard OGO-5 American satellite, 25:58574
BERTOLINI, G., Background measurement of a Ge(Li) detector, 25:57803
BERTOLUCCI, B., Proportional wire chamber electronics system utilizing CAMAC, 25:59656
BESKORSKII, A. I., High-sensitivity thermally stimulated exoelectron emission element for gamma dosimeters, 25:57836
BESPALOV, M. S., Experimental determination of the electron concentration and temperature of an argon plasma jet by means of lasers, 25:58987
BESSIS, G., Eigenfunctions of angular momentum operators in J--J coupling, 25:58801
BESSIS, N., Eigenfunctions of angular momentum operators in J--J coupling, 25:58801
BESSONOV, A. F., Interaction of amorphous uranium trioxide with carbon monoxide, 25:57417
BESSUGES, Medical surveillance of workers in the storage center for radioactive waste, 25:57978
BETER, E. V., Inelastic pion--nucleon interactions with high multiplicity and the one-pion exchange model, 25:59496
BETZ, H. D., Charge-changing cross sections for heavy ions in complex molecules, 25:58768
BETZ, N., Proposal for computer assisted data acquisition for ORNL fusion experiments, 25:59075 (ORNL-TM-3593)
BEUERMANN, G., Electron paramagnetic resonance of electron-irradiated ammonia layers, 25:57470
BEUHRING, V. F., Metallographic analysis of carbide structures in cast heat-resistant alloys, 25:58399
  Nickel- and cobalt-base alloys, 25:58203
BEYNON, T. D., Effect of accelerator pulse shapes on neutron slowing down times, 25:60232
BEZAGUET, A., Heavy liquid bubble chamber analysis of eta^0 neutral decay modes, 25:59244
BEZ'YAZYCHNII, I. A., Plasma density measurement by means of an open resonator, 25:58977 (AEC-tr-7271)
BHATNAGAR, A., Two-dimensional observations of the velocity field in and around sunspots, 25:58598
BHOWMIK, G., Electrohydromagnetic instability of superposed fluids, 25:58842
BIBILASHVILI, M. F., Groups of parallel penetrating particles and their possible sources, 25:58828
BIDARD, Rene, MHD power plant using a liquid metal emulsion, 25:58841
BIEDENHARN, L. C., Mechanism for CP nonconservation, 25:59539

BIEGUSZEWSKI, Zygmunt, Primary coolant purification system in the EWA-10 reactor, 25:60157 (INR-1316)
BIGELEISEN, Jacob, Calculation of some isotope separation factors for chemical exchange, distillation, exchange distillation, and absorption using UF/sub 6(g)/, 25:57528 (UR-3999-11)
BIGGS, P. J., Real part of the rho--nucleon forward scattering amplitude and the relative rho--ω production phase, 25:59252
BILDSTEIN, H., Reprocessing of oxidic thorium-containing nuclear fuel particles with chlorine gas, 25:57542
BILEN'KII, S. M., $\pi^+ \to e^+(\mu^+)\nu e^+e^-$ decays, 25:59412
BILLARD, F., Pollution of the atmosphere in uranium mines, 25:57564
BILLINGS, Dana F., Oscillations of a magnetic polytrope, 25:58507
BINON, F., Coulomb-nuclear interference in π^---^{12}C elastic scattering, 25:59713
BIR, R., Plutonium production in NPD: comparison between experiment and calculation, 25:60093 (AECL-3995)
BIRCH, William, Nuclear reactor installations, 25:60146
BIRD, J. R., Measurements of γ-radiation following keV neutron capture in Zn, 25:59759
  Particle accelerators, 25:59650
BIRGE, R. W., π^+p elastic scattering data between 1820- and 2090-MeV cm energy, 25:59309
BIRSS, I. R., New source of helium in cladding materials, 25:58336
BIRYUKOV, E. I., Activation detector, 25:57729
BISHOP, J. F. W., Significance of fast neutron induced voids in the design and performance of fast reactors, 25:58331
BISKAMP, D., Asymptotic behavior of the two-stream instability, 25:59062 (IPP-6/97)
  Validity of quasi-linear approximation for turbulent plasmas, 25:59027 (IPP-6/94)
BISWAS, N. N., Limiting distributions for target fragmentation in reactions $\pi^{+-} + p \to \pi^- +$ anything, 25:59319
BISWELL, L. R., CAMAC systems at LAMPF, 25:59654
BJOERNENAK, K., Elastic and single-charge-exchange scattering of pions by carbon nuclei, 25:59523
BJORKLUND, W. J., First product denitration campaign with enriched uranium at ICPP, 25:57397 (IN-1475)
BLACK, R. A., Velocity cross section 5, extending southwest from Tatum dome, Lamar County, Miss, 25:57595 (USGS-474-112)
BLACK, Stuart C., Radionuclide studies with dairy cows following two Plowshare experiments, 25:57948 (SWRHL-85-r)
BLACKBURN, L. D., Mechanical properties of fast reactor irradiated austenitic stainless steel weldment materials, 25:58296 (HEDL-SA-196)
BLAGHIKH, Assia, Space distribution of evolving stars in M13, 25:58487
BLAIR, Roy C., Plugging compound collector, 25:57624
BLAISE, J., Present state of analysis of Nd I and Nd II, 25:58705
BLAKE, J. P. H., Air flow through concentric ducts separated by a porous pipe, 25:57645
BLAMONT, J. E., CNES and space astronomy, 25:58444
BLANC, D., Soft x-ray spectrometry with semiconductors operating in a cascade regime, 25:57771
BLANCHARD, Ph., LiF radiothermoluminescent dosimeters which can be reused without regeneration, 25:57848
BLANKENBECLER, R., Bound on absorptive part of elastic scattering amplitudes, 25:59630
  Deuteron electromagnetic form factor, 25:59379
BLANKENSHIP, Willard, Cell line initiation from cord blood leukocytes treated with viruses, chemicals, and radiation, 25:57921
BLASCHKE, R., Morphology and chemistry of magnetite layers, 25:58165 (AEC-tr-7237)
BLASHCHUK, V. E., Weldability and corrosion resistance of titanium--5 percent tantalum alloy, 25:58176
BLEICHRODT, J. F., Induction of mutations in bacteriophage by ionizing radiation, 25:57971
BLEWETT, John P., Fusion reactions in self-colliding orbits, 25:59078
BLINOVA, O. P., Detection of defects in butt welds with beta rays, 25:57700
BLOKLAND, A., Decisive test for general relativity, 25:58664
BLOMGREN, Henric, Role of bone marrow of x-irradiated mice in thymic recovery, 25:58115
BLOMQVIST, J., E2 core polarization by neutrons in (i/sub 13/2/)$^{-2}$ configuration in ^{206}Pb, 25:59818
  Evidence for high-spin core-excited states in ^{210}Po, 25:59817
BLONDET-GONTE, Gilbert, Specific heat of neutron irradiated graphite between 1.4 and 4.4°K in presence of a variable magnetic field (0 to 40 kGs), 25:59148
BLUM, Manfred, Environmental contamination with ^{131}I related to the treatment of hyperthyroidism and carcinoma of the thyroid gland, 25:58079
BLUMENFELD, A. L., Radicals in γ-irradiated hydrates of three-membered cycles, 25:57476
BOBKOV, V. G., Microdistribution of fission density in VVR-M, 25:60172
BOBROVSKII, G. A., Dependence of energy loss from Tokamak plasma on effective electron collision frequency, 25:58974
BOBYR, V., Coulomb-nuclear interference in π^---^{12}C elastic scattering, 25:59713
BOCHAROVA, R. I., Spectrophotometric determination of small amounts of scandium and yttrium in each others presence, 25:57318
BOCHEK, G. L., Arrangement for direct nuclear reactions produced by electrons and gamma quanta up to 300 MeV, 25:59646
BOCHNACKI, Z., Calculation of neutron equilibrium pairing in spherical single closed shell nuclei, 25:59833 (JINR-E4-5907)
BOCK-WERTHMANN, W., Bibliographies in nuclear science and technology. Section 14, 25:57368 (AED-C-14-5)
BOCOLA, W., Gaseous RuO$_4$ removal by ferric oxide-silica filters, 25:57532
BOECKMANN, K., Analysis of A$_1$ and A$_2$ regions in reaction $\pi^+p \to \pi^+\pi^+\pi^-p$ at 5 GeV/c, 25:59475
BOEHM, Richard, Many-body theory of autoionization, 25:58802
  van der Waals forces including exchange in small overlap region, 25:58809
BOERBOOM, A. J. H., Diffusion coefficients of isotopic methane mixtures and of methane--rare gas mixtures, 25:57434
BOERNER, Gerhard, Neutron star models, 25:58493
BOETTER-JENSEN, L., Read-out instruments for solid thermoluminescence dosimeters, 25:57843
BOGDAN, F., Cellular divisions in human epidermis under influence of x rays, 25:58146
BOGDANOV, Yu. A., Influence of iron on the physicochemical state of radioelements in sea water, 25:57410
BOGDANOVE, L. H., Operant behavior of pre- and post-pubertal rats irradiated with ^{131}I, 25:58100
BOGDANOVICHYUS, P. O., Theoretical calculation of energy levels for rare earth element ions, 25:58709
BOGOLYUBOV, P. N., Coherent state method and the quark model, 25:59448 (JINR-E2-6025)
BOGUTA, J., Isobaric five-point function and anti pp $\to 4\pi$ at rest, 25:59470
  Planar duality constraints on the multibody model, 25:59446
BOIGE, F., Survival of Azotobacter chroococcum following γ irradiation and ibenzmethyzine treatment, 25:58156
BOISOT, P., Does oxidation of Zr obey Wagner's theory, 25:58254
BOITI, M., Some consequences of the asymptotic scaling assumption, 25:59342
BOJKO, Ignacy, Hindered rotation at 2°K of the NO$_2$ impurity in KCl, 25:59199 (NYO-2150-74)
BOLDEMAN, J. W., Energy dependence of anti ν/sub p/ for ^{233}U, ^{235}U, and ^{239}Pu, 25:59810
BOLDRIGHINI, C., Realization of chiral symmetry in meson states through SU(4) x O(3), 25:59551
  Remarks on inclusive experiments and high energy models, 25:59322 (NP-19024)
BOLLINI, D., Evidence for decay mode $X^0 \to \gamma\gamma$ and determination of branching ratio $X^0 \to \gamma\gamma/X^0 \to$ total, 25:59290
BOLON, G. C., Photoproduction of π^0's from neutrons at 4 GeV, 25:59243
BOL'SHAKOV, P. P., Residual stresses in cermets, 25:58381
BOLSTERLI, M., Finite-difference solution of axially symmetric nuclear single-particle potentials, 25:59839 (LA-4735)
BOLTON, C. T., Spectral synthesis of low-dispersion luminosity criteria in A- and F-type stars, 25:58438
BOND, Howard E., Subluminous B-Type star CD -42° 14462, 25:58456
BONDARENKO, B. V., Electrical resistance and structure of films of W, Mo, and Cr produced by laser evaporation, 25:59186
BONDARENKO, V. P., Electric properties of alloys of LaB$_6$ with transition metals. I, 25:59182
  Temperature dependence of electrophysical properties of alloys of LaB$_6$ with transition metals. II, 25:59183
BONHAM, R. A., New values for partial-wave electron scattering factor for elements 1 less than or equal to Z less than or equal to 57 and 72 less than or equal to Z less than or equal to 90, 25:58748
BONIFACIO, R., Analytical result about co-operative spontaneous emission, 25:58812
BONNET, A., Study of anti pp annihilation at 2.5 GeV/c with production of two kaons in final state, 25:59272
BOOTH, E. S., Whither nuclear power, 25:60030
BORCEA, C., Absolute measurement of ^{239}Pu fission cross-section for 2200 m/sec neutrons, 25:59777 (IFA-NR-33)
BORDENAVE-MONTESQUIEU, Alain, Excitation of auto-ionization levels of He by collision with a heavy particle, 25:58779
BORDERS, J. A., Preferential etching of ion-bombarded GaAs, 25:59141
BORGSTEDT, H. U., Oxidation behaviour of nickel--vanadium alloys in air, 25:58251
BORICHEV, A. A., Methods of determination of ^{137}Cs in objects of external environment, 25:57355
BORIS, J. P., Solution of partial differential equations using symbolic style of Algol, 25:59216
BORISOV, A. E., Optimal time of using a radioisotope source of radiation in nondestructive testing, 25:57697
BORISOV, M. S., Bremsstrahlung yield as function of target thickness and atomic number in electron energy range 12

to 22 MeV, 25:59106
BORONOW, Richard C., Vesicovaginal fistula, radiation, and gynecologic cancer, 25:58135
BORRA, Ermanno F., Recovery and final decline of Nova Serpentis 1970, 25:58450
BORREANI, G., Reaction $\pi^+ p \to \Sigma^+ K^+$ at 1.28 and 1.41 GeV/c and a test of charge independence, 25:59311
BORZA, A., Absolute measurement of ^{239}Pu fission cross-section for 2200 m/sec neutrons, 25:59777 (IFA-NR-33)
BOSE, S. K., Inequivalence of representations of commutation relations obtained by orthogonal transformations in field theory, 25:59567
BOSS, M. R., Plutonium metal criticality measurements, 25:57718
BOSTROEM, Kurt, Anomalous ^{234}U/^{238}U on East Pacific Rise, 25:57585
BOTOR, Jan, Current efficiency in alumina electrolysis. II, 25:58360
BOTTCHER, C., Iterative perturbation solution of the inverse potential problem, 25:58772
BOUCHER, Rene, α-ray heat source, suitable for use in a cardiac pacemaker, 25:57668
BOUCHIAT, Cl., Galilean invariance in the infinite momentum frame and the parton model, 25:59431
BOULAY, P., Direct measurement of pulmonary plutonium contamination, 25:57773
BOULGER, F. W., Metalworking, 25:58199
BOULINIER, C., Phenix reactor, 25:60087
BOURGEOIS, Christian, Determination of electromagnetic transition probabilities from measurements of mean lives of excited nuclear states; application to ^{140}Ce, ^{191}Pt, and ^{135}La nuclei, 25:59776 (FRNC-TH-56)
BOURQUIN, M., Measurement of K/sub e4/$^+$-decay rates and test of $\Delta S = \Delta Q$ rule, 25:59262
BOWCOCK, J. E., Conference on methods and problems of theoretical physics, Birmingham, Eng., 6/67, 25:59209
BOWMAN, C. D., Threshold photoneutrons and photon doorways, 25:59784 (UCRL-73336)
BOWMAN, D. R., Use of an on-line digital computer for enhancement and integration of nuclear resonance spectra, 25:57887
BOWYER, Stuart, Evidence for a highly compact x-ray source, 25:58534
BOX, W. D., Preparation of neutron dosimeters for reactors, 25:57724 (CONF-711002-, pp 86-90)
BOYCE, R. F., Observation of slip bands in molybdenum single crystals by x-ray diffraction, 25:58271 (CALT-767-P-3-15)
BOYER, Charles P., Decomposition SO(p,1) is contained in SO(p -1,1) for most degenerate representations, 25:59535
BOYER, R., Isotopes of magnesium in the solar atmosphere, 25:58597
BOYMOND, J. P., Measurement of K/sub e4/$^+$-decay rates and test of $\Delta S = \Delta Q$ rule, 25:59262
BOZHICHKO, M. A., Photometric method for the determination of ultramicroquantities of thorium in rocks, 25:57342
BOZHKO, S. A., Collective recrystallization in zirconium carbide after surface cold-hardening, 25:58394
BRABEN, D. W., Real part of the rho--nucleon forward scattering amplitude and the relative rho--ω production phase, 25:59252
BRACHET, Guy, Development of ^{242}Cm--Be and ^{238}Pu--Be neutron sources, 25:59669 (CEA-R-4172)
BRACKEN, A. J., Vector operators and polynomial identity for SO(n), 25:59538
BRADAMANTE, F., Comparison of high-energy hadron--deuteron scattering data with Glauber model, 25:59269
BRADLEY, R. F., Radiolysis of liquid waste during bedrock storage, 25:57459 (DP-1264)
BRAGA-MARCAZZAN, M. G., Pre-equilibrium emission in n,p and n,α reactions of CsI, 25:59826
BRAILOVSKAYA, I. Yu., Solar flare prediction, 25:58592
BRAILOVSKII, V. L., Solar flare prediction, 25:58592
BRAKENHOFF, G. J., Production of a very quiescent plasma in skipping magnetic fields, 25:59055
BRAMBILLA, M., Parameter study for a Transit Time Magnetic Pumping experiment in a torus, 25:58959 (CEA-CONF-1830)
BRAMBLETT, R. L., Application of photoinduced reactions to nuclear materials safeguards problems. Project summary report, July 1, 1970--June 30, 1971, 25:57704 (GULF-RT-A-10826)
BRAMMAN, J. I., Density changes in cladding materials irradiated in DFR, 25:58306
  Electron microscope observations of voids in cladding materials irradiated in DFR, 25:58307
  Fast neutron induced voidage in non-fissile metals and alloys, 25:58305
BRAMWELL, S. E., Compton and Rayleigh scattering of x rays by heterogeneous materials, 25:59118
BRANCH, D., Wavelength shifts of intensity minima in Type-I supernova spectra, 25:58501
BRANDENBURG, G. W., Application of multi-Regge model to reaction $\pi^- p \to p\pi^+\pi^-\pi^-\pi^0$ at 13 and 20 GeV/c, 25:59300
BRANDOLINI, F., Lifetime measurements in sd shell nuclei. VII, 25:59751
BRANDSTETTER, A., Simple ionization measuring device for bubble chamber pictures, 25:57825 (RPP/H-81)
BRANDT, N. B., Superconductivity of gallium arsenide at high pressures, 25:58944
BRANDT, Richard A., Configuration-space view of high-energy scattering, 25:59617
BRANFORD, D., Evidence for negative parity rotational bands in ^{24}Mg, 25:59767
BRANSDEN, B. H., Partial wave amplitudes for $\pi^- p$ elastic scattering and charge exchange in 2 to 5 GeV/c region, 25:59304
BRASHER, William Ernest, Distribution of nighttime F-region molecular ion concentrations and 6300 A nightglow morphology, 25:58884
BRAULT, J., Abundance of chlorine in Sun, 25:58593
BRAUN, H., Reaction anti pd $\to$ p/sub s/$\pi^+ 2\pi^- \pi^0$ at 5.5 GeV/c, 25:59276
BRAUN, Howard E., Nuclear reactor control device, 25:60244
BRECHER, K., Counts of sources and theories, 25:58659
BREDIKHIN, M. Yu., Heating of a hot plasma created by an electron beam, 25:58972
BREDOHL, H., Determination of frequency of 10-cm radio line of CH, 25:58700
BREHIN, S., Determination of low-energy π--π phase shifts and form factors in K/sub e4/$^+$ decay, 25:59263
BREHM, J. J., Sigma commutator and features of (8,8) symmetry breaking, 25:59550
BREITENHUBER, L., Reactor kinetic calibration of neutron sources and its comparison with bath methods, 25:59688
BREKHOVSKIKH, S. M., Radiation effects on glass and ceramics, 25:59147
BREKKE, A., Correlation between pulsating aurora and cosmic radio noise absorption, 25:58858
BRENNER, A. E., Application of multi-Regge model to reaction $\pi^- p \to p\pi^+\pi^-\pi^-\pi^0$ at 13 and 20 GeV/c, 25:59300
BRENNER, R., Computer controlled CAMAC systems at Argonne, 25:57884
BRESSANI, T., Isovector potential in ^{208}Pb from partial muon capture, 25:59808
BRESSERS, J., Purification of vanadium and production of vanadium single crystals through zone melting, 25:58192
BRETTHAUER, Erich W., Radionuclide studies with dairy cows following two Plowshare experiments, 25:57948 (SWRHL-85-r)
BREUER, Hans, Radiative correction for elastic electron- and positron-nucleus scattering, 25:59880
BREVI, R., Measurement of the effect of twisted tapes on the forced-convection heat transfer and burnout in heat exchangers, 25:57643
BREWER, John, Eddy-current probe-type sodium flowsensor for FFTF reactor fuel channel flow monitoring, 25:60184
BREY, C., Multiple proportional gas counter for the cartography of radioelements, 25:57774
BRICMAN, C., Baryon decay rates within SU(3), 25:59491
  Experimental test of semi-local duality in $K^- p \to$ anti $K^0 n$ backward scattering, 25:59482
BRIDGEWATER, A., Precision measurement of lifetime and decay branching ratio of Λ^0 hyperon, 25:59260
BRIGHT, G. O., Light-water-reactor safety, 25:60131
BRILL, Aaron B., Multicrystal tomographic scanner for mapping thin cross section of radioactivity in an organ of the human body, 25:57754
BRIMHALL, J. L., Effect of neutron irradiation on mechanical properties of rhenium, 25:58342
  Microstructural analysis of neutron-irradiated titanium and rhenium, 25:58302
BRISCOE, W. L., Dividing head tabulations, 25:60273 (LA-4421)
BRISCOE, William L., Delay time studies in a channel electron multiplier, 25:57895
BRITTIN, Wesley E., Phase space and quantum theory, 25:59234
  Topics in modern physics, 25:58682
BROCKLEHURST, B., Light emission from gamma-irradiated alkane glasses containing olefins, 25:57463
BROCKLEHURST, M., Level populations for low levels of hydrogenic ions in gaseous nebulae, 25:58516
BROCKMAN, Stanley R., Earthquakes on and around Nevada Test Site, 1950--71, 25:57589 (CGS-746-12)
BROECKERHOFF, Peter, Heat transfer of tube shaped fuel elements of the central channel of a reactor of the type natural uranium-gas-graphite, 25:57639 (JUL-753-RB)
BROOKSHIER, W. K., Energy control and monitoring system for a tandem Van de Graaff, 25:59653
BROWN, G. E., Many-body problems and two-body forces, 25:59850
BROWN, G. S., Photometric observations of supernova 1971 in NGC 4165, 25:58464
BROWN, Lowell S., Current algebra and analyticity, 25:59469
BROWN, McKay, Detection of antinuclear antibodies in NAB and other mouse strains, 25:60285 (RLO-2226-T-3-8)
BROWN, Nicholas Everett, Phenomenological analysis of pion conspiracy models, 25:59429
BROWN, P. E., Chest clearance of inhaled ^{60}Co oxide, 25:57995 (CONF-711013-1)
BROWN, R. A., Distribution of T/sub </ states in ^{89}Y, 25:59750
BROWN, R. W., Intermediate boson. II, 25:59410
BROWN, Russell L., Eddy-current probe-type sodium flowsensor for FFTF reactor fuel channel flow monitoring, 25:60184
BROWN, V., CEGB experience of in-pile working, 25:59925
BROWN, W. K., Method of calibration of Moxon--Rae

detectors, 25:57789
BRUCATO, Robert J., Time variations in the emission lines of cf stars, 25:58515
BRUECKNER, Keith A., Collision broadening by neutral hydrogen, 25:58509
BRUMOVSKY, M., Development of pressure vessel steels for Czechoslovak Nuclear Stations, 25:58216 (ZJE-106)
BRUNEAU, M., Optical potential for nucleon scattering on ^{40}Ca, 25:59744
BRUNELLE, R. L., Use of neutron activation analysis for the characterization of paper, 25:57374
BRUNNER, H., Recent advances in radiation protection measurement techniques, 25:57767
BRUNSKILL, R. T., Sealed thermoluminescent dosimeter employing rf heating for routine individual monitoring, 25:57839
BRUNSON, G. S., Experimental irradiations of fuel elements having known cladding defects in EBR-II, 25:60082 (ANL-7782)
BRUSCHI, C., Reactor physics heterogeneous methods developed at CISE. I, 25:60040
BRUSLE, Jacques, Radiosensitivity of gonad of Asterina gibbosa following x irradiation, 25:58090
BRUSSAARD, P. J., Pairing factors for electric transition operators, 25:59863
BRUST, R., Construction of response matrices in γ-scintillation spectrometry, 25:57795 (LB/G-3075)
BRUYNESTEYN, A., Enhancing bacterial activity in a uranium mine, 25:57582
BRYNIELSSON, H., Nuclear energy in Sweden, 1970, 25:59890
BRZOSKO, J. S., Measurement of γ-ray spectra accompanying radiative capture of nucleons, 25:59801
BUCCELLA, F., Realization of chiral symmetry in meson states through SU(4) x O(3), 25:59551
BUCHHOLZ, H., Size classification of submicron particles by a low-pressure cascade impactor, 25:57573 (ORNL-4226)
BUCHHOLZ, K., New virtual and analogue states in ^{47}V, 25:59752
BUCHNER, K., Application of unitarized Veneziano model to reaction $K^+n \rightarrow K^+\pi^-p$ at 3 GeV/c, 25:59478
BUCINA, I., Absolute activity measurement of ^{3}H, 25:57505
BUCKLEY, Donald H., LEED study of adhesion of Cu and W to (111) surface of Ni, 25:58270
BUCKLEY, S. N., Production of voids in cobalt during ion bombardment and electron irradiation, 25:58325
BUDARIN, L. I., Kinetic method for analyzing mixtures of rare earth elements, 25:57319
BUGNOLO, Dimitri S., Anomalously large scattering by turbulent, weakly ionized plasma, 25:59039
BUHL, A. R., Precision of shutdown margin measurements using the two-frequency reactor noise technique in an LMFBR, 25:60043
BUI-DUY, Q., Renormalized field product, Bjorken limit, Ward identity, and static model, 25:59564
BUINOV, N. N., Structure of superconducting alloy Ti--22 at. percent Nb, 25:58942
BUKLANOV, G. V., Electromigration separation of transuranium elements in solutions of ethilendiamintetracetic and cyclohex andiamintetracetic acids, 25:57520 (JINR-E6-5952)
BUKOW, H. H., Lifetimes and relative initial-state populations of some hydrogen atomic states using beam--foil spectroscopy, 25:58722
BULGAKOV, Y. V., Effect of neutron and alpha-particle irradiation upon physical properties of α-SiC, 25:59154
BULLOUGH, R., Interaction between a void and a dislocation loop, 25:58315
  Theory of void growth in irradiated materials, 25:58312
  Void lattice in molybdenum, 25:58313
BURASTERO, J. J., Polarographic determination of uranium in monazite sands, 25:57334
BURBIDGE, G., Counts of sources and theories, 25:58659
  Was there really a big bang, 25:58666
BURGER, G., Applicability of track detectors in neutron dosimetry, 25:57855
  Spectra and conversion factors of neutron calibration sources, 25:57676
BURGESS, D. D., Optical generation of electron plasma waves, 25:59101
BURGINYON, G. A., X rays from Puppis A and the vicinity of Vela X, 25:58561
BURKHANOV, G. S., Effects of thermal cycling of monocrystals of tungsten--molybdenum alloys, 25:58247
  System molybdenum--nickel--carbon, 25:58290
BURKHARDT, H., Singularities of the S-matrix, 25:59613
BURLIN, T. E., Physical measurements on a ^{60}Co irradiation unit, 25:57631
BURMAN, R., Cross sections for (π^+,p) reactions on ^{9}Be, ^{12}C, and ^{16}O, 25:59710 (LA-DC-12781)
BURMAN, R. L., New measurements of (π^+,2p) reactions on light nuclei, 25:59709 (LA-DC-12389)
BURNETT, J. L., Electron-transfer and f → d absorption bands of some lanthanide and actinide complexes and standard (III--IV) oxidation potentials for each member of lanthanide and actinide series, 25:57437
BURNHAM, John B., Economic vs biological risk as reactor design criteria, 25:60003
BURNS, D. J., Absolute cross section for electron impact excitation of 3914-A N_2^+, 25:58726
BUROV, L. M., Fine structure parameters of Al--W, Al--Mo, and Al--Mn alloys obtained at high cooling rates, 25:58284
BURRELL, M. O., Risk of solar proton events to space missions, 25:58853 (N-71-27792)
BURROWS, K., Rocket measurements of magnetic fields associated with visual aurorae, 25:58857
BURTIS, D. W., Programmable solid state pulser for charge-sensitive amplifier systems, 25:57896
BURTSEV, V. T., Determination of the oxygen content in metallic ruthenium, 25:57329
BURYLO, Piotr Stanislaw, Fluid-cooled nuclear reactor, 25:60073
BUSCH, Herbert, Manufacture of fuel elements for reactor at Grosswelzheim, 25:58205
BUSEY, Harold M., Earthquake-resistant nuclear reactor station, 25:60091
BUSSE, Claus A., Fuel elements for use in thermionic nuclear reactors, 25:60199
BUSTAMANTE, Norma T., Thermoluminescence dosimetry studies, 25:57845
BUSTRAAN, M., Determination of effective cross sections of fission products for fast breeders in the fast-thermal coupled critical reactor STEK, 25:60159 (RCN-150)
BUSWELL, J. T., Growth of voids in stainless steel, 25:58329
BUTA, A., Absolute measurement of ^{239}Pu fission cross-section for 2200 m/sec neutrons, 25:59777 (IFA-NR-33)
BUTLER, Murdock M., Ordering of carbon--hydrogen bond strengths using isotope effects, 25:57426
BUTLER, P. H., S-functions and symmetry in physics, 25:58790
BUTLER, S. T., Deuteron-induced reactions, 25:59848
BUTLER, W. R., Evidence for a charge asymmetry on ω Dalitz plot, 25:59308
  π^+p elastic scattering at 3.6 GeV/c, 25:59292
BUTTLAR, H. v., Lifetimes and relative initial-state populations of some hydrogen atomic states using beam--foil spectroscopy, 25:58722
BUTZ, H. P., Total effective cross sections for scattering of He, HD, and D_2 by several molecules, 25:58782
  Total effective scattering cross sections of HD-inert gas systems in thermal energy region, 25:58781
BUTZ, T., Measurements of NMR on oriented ^{192}Ir and /sup 191m/Ir in Ni and Fe host lattices, 25:59807
BUU-HOI, N. P., Enhancement of the carcinogenicity of 7,12-dimethylbenz[a]anthracene through replacement of H by deuterium, 25:57920
BUYANOVSKAYA, A. G., Group concentration of elements by extraction with a hydroxyquinoline melt, 25:57312
BYCHKOV, Yu. F., Structure of superconducting alloy Ti--22 at. percent Nb, 25:58942
BYRER, T. G., Metalworking, 25:58199
BYRNE, A. R., Neutron activation analysis of Sn, 25:57378
BYSZEWSKI, Witold, Intercomparison measurements of SKODA and INR calorimeters on EWA-10 reactor, 25:57875 (INR-1319)

C

CAFASSO, F. A., Prog. rpt. on physical chemistry of liquid metals and molten salts, semiannual, 1--6/71, 25:58387 (ANL-7823)
CAGLE, C. D., Dresden 2 incident of June 5, 1970, 25:59917
CAILLERET, J., Formation of iodides in solid butane irradiated by I^+ ions, 25:57499
CAIMMI, G. F., Reactor physics heterogeneous methods developed at CISE. I, 25:60040
CAIRNS, E. J., Prog. rpt. on physical chemistry of liquid metals and molten salts, semiannual, 1--6/71, 25:58387 (ANL-7823)
CALLES, A., The pseudo-atom: a soluble many-body problem, 25:58796
CALOGERO, F., Exact ground state of some one-dimensional N-body systems with inverse (Coulomb-like) and inverse-square (centrifugal) pair potentials, 25:59840 (NP-19027)
CALS-USCIATI, Josette, Post-embryonic development of γ-irradiated Ceratitis capitata larvas, 25:58094
CALVI, A., Use of radioactive tracers in the study of breast cancer, 25:58051
CAMBI, A., Spin and parity of some excited states of ^{48}Sc, 25:59756
CAMBINI, M., Substructure of γ-vanadium suboxide resulting from long range ordering of oxygen, 25:58392
CAMPBELL, A. N., Ternary system silver--indium--aluminum, 25:58287
CAMPBELL, George M., Thermodynamic properties of $PuRu_2$ from EMF measurements, 25:58211 (LA-4758)
CAMPBELL, H. D., Plasma diagnostics of a uranium plasma, 25:59000
CAMPISANO, S. U., Proton dechanneling in Ge probes, 25:59130
CANNON, W., Electric space potential in a cesium thermionic diode, 25:58838 (N-71-26273)
CANO, R., Nonlinear harmonic generation in a thermal magnetized plasma, 25:59013 (CEA-CONF-1835)
CANONICO, D. A., Tensile and impact properties of thick-section plate and weldments, 25:58218
CANTER, Karl Frederick, Positron processes in H, He, Ar, and Ne gas, 25:58725
CAPELLA, A., Pion Regge trajectory, 25:59460

CAPES, H., Electron correlations in unified line shapes, 25:59026 (CEA-CONF-1834)
CAPITAIN, J. J., Plasma heating at the lower-hybrid resonance, 25:58960 (CEA-CONF-1831)
CAPPELLANI, F., Background measurement of a Ge(Li) detector, 25:57803
CARBIENER, Wayne A., Prog. rpt. on applicability of data to the description of reactor accident, 4--6/71, 25:60111 (BMI-1917)
CARDY, J. L., Wide angle scattering in quantum electrodynamics, 25:59354
CARFI, N., Setting-up of a neutron dosimeter using ionographic tracks in an insulating solid, 25:57856
CARLE, Remy, Some ideas on the experience gained during the construction of fast breeder reactors, 25:60007 (CONF-710922-1)
CARLE, T., Fast neutron reactor Phenix, 25:60039
CARLOS, Robert C., HD 21242: spectroscopic binary with H and K emission, 25:58461
CARLSON, B. G., Properties of new numerical approximations to the transport equation, 25:59113
CARLSON, J. D., New (p,n) reaction studies at Ep = 23 MeV, 25:59789
CARLSON, O. N., V--VO phase system, 25:58406
CARLSON, Thomas A., K--LL Auger spectra of N_2, O_2, CO, NO, H_2O, and CO_2, 25:58736
CARMAN, R., Proportional wire chamber electronics system utilizing CAMAC, 25:59656
CARMONY, D. D., Observation of new K/sub N/(1760) in $K\pi$ and $K\pi\pi$ systems, 25:59318
CARNESALE, A., Semiempirical formulas for gamma-ray dose rates through two-layer slab shields, 25:59108
CARPENTER, G. J. C., Diffusion coefficient as a guide to prospects for high-temperature zirconium alloys, 25:58208 (AECL-3967)
CARR-BRION, K. G., Compton and Rayleigh scattering of x rays by heterogeneous materials, 25:59118
CARRE, M., Polarization of H/sub β/ line emitted in $Li^+ + H_2$ collisions, 25:58780
CARROLL, J. T., Observation of natural-parity exchange in rho^0 production, 25:59286
CARROLL, J. W., Preparation of tungsten-modified mixed carbide, 25:58365 (AI-AEC-12983)
CARTER, Anthony P., Schilder's disease. Positive brain scan, 25:58048
CARTER, G., Ion implantation of binary III--V semiconductors, 25:59168
CARTER, K. W., Magnetic analysis of reactions ^{7}Li(^{3}He,d)^{8}Be and ^{7}Li(^{3}He,t)^{7}Be, 25:59731
  Search for high-spin states in ^{27}Al, 25:59761
CARTWRIGHT, D. C., Selection rule for Σ^+ in equilibrium Σ^- transitions in electron--molecule collisions, 25:58732
CARUSO, A., Producing 0.1-GeV ions by focusing ultrashort laser pulses on thin foils, 25:59341
CARVALHINHOS, H., Techniques for preparation of UO_2--niobium (or molybdenum) cermets, 25:58348 (LFEN-NI.-53-a)
CARVALHO, Frederico Gama, Introduction to the study of the problem of scattering of slow neutrons by condensed matter, 25:59673 (LFEN-NI.-51-a)
CARVER, M. B., Package of computer programs for the analysis of temperature distribution in three dimensional systems, 25:60260 (AECL-3783(Rev.1))
CASA, A. F., Nuclear energy in Europe, 25:59901
CASARETT, Louis J., Pulmonary cell responses to metallic oxides, 25:57923
CASARETT, Margaret G., Pulmonary cell responses to metallic oxides, 25:57923
CASE, K. M., Fourier transform methods in linear transport theory, 25:59121
CASO, C., Analysis of the reaction $\pi^+p \to$ rho$^0\Delta^{++}$ at 11.7 GeV/c incident momentum. II, 25:59499
CASOLO, F., Clinical and technical observations in therapy with 42 MeV betatron, 25:58076
CASPERS, W. J., Complete sets of diagonal operators in quantum-statistical mechanics, 25:59222
CASSELL, J. S., Propagation of sound waves and neutron waves in bounded plane geometry, 25:59679
CASSINELLI, J. P., Radiative transfer in spherically symmetric systems. II, 25:58510
CASTAGNINO, Mario A., Riemannian structure of space--time as a consequence of a measurement method, 25:59608
CASTEL, B., Compressibility under deformation of the nuclear Hartree--Fock field, 25:59877
CASTELLANI, Vittorio, Space distribution of evolving stars in M13, 25:58487
CASWELL, J. L., Search for southern OH--ir objects, 25:58466
CATTANEI, G., Collisionless plasma heating at the ion cyclotron resonance, 25:58973
CATTANI, M., Luminosity of high-temperature stars, 25:58433
CATURA, R. C., Helium-like line-emission coronal features, 25:58621
CAWTHORNE, C., Density changes in cladding materials irradiated in DFR, 25:58306
  Electron microscope observations of voids in cladding materials irradiated in DFR, 25:58307
  Fast neutron induced voidage in non-fissile metals and alloys, 25:58305
CELEGHINI, E., Realization of chiral symmetry in meson states through SU(4) x O(3), 25:59551
CERTAIN, Philip R., Exchange perturbation theory and HeH^+ ion, 25:58702
CERVANTES, Abelardo, ^{75}Se-selenomethionine in scintallography of thyroid and hepatic lesions, 25:58054
CHABRILLAC, M., Plutonium production in NPD: comparison between experiment and calculation, 25:60093 (AECL-3995)
CHADDERTON, L. T., Scattering of charged particles by single crystals. I, 25:59157
CHADWELL, C. B., Neutron emission rate reduction in PuO_2 by oxygen exchange, 25:57655 (MLM-1844)
CHAFFEE, Frederic, Energy distributions and spectra of Orion B stars, 25:58503
CHAFIN, Robert V., Log of Hydrologic Test Well 1, Tatum dome area, Lamar County, Mississippi. Dribble-6, 25:57562 (USGS-474-110)
  Log of Hydrologic Test Well 2, Tatum dome area, Lamar County, Mississippi. Dribble-7, 25:57563 (USGS-474-111)
CHAIKHORSKII, A. A., Theory of the actinides, 25:57438
CHAISSON, Eric J., Radiofrequency detection of an anomalous interstellar recombination line, 25:58563
CHAKRABARTI, A., Lorentz basis of Poincare group. II, 25:59533
  Remarks on lightlike continuous spin and spacelike representations of Poincare group, 25:59532
CHAKRAVARTI, R. N., Agents protecting skin against acute radiation, 25:58036
CHAN, F. K., Physical measurements on a ^{60}Co irradiation unit, 25:57631
CHANDRA, H., Effect of magnetic activity on electron drifts in equatorial electrojet region, 25:58905
CHANDRA, Naresh, Nonlinear scattering of partially coherent radiation by free electrons, 25:59225
CHANDRA, Ramesh, Environmental contamination with ^{131}I related to the treatment of hyperthyroidism and carcinoma of the thyroid gland, 25:58079
CHANDRAKER, K., Initiating intense discharge plasma at very low gas pressures, 25:59022
CHANG, Chau-ting, Behavior of Np in aqueous solution. II, 25:57535
CHANG, J. Y., Examination of the microstructures of mixed uranium--plutonium dioxide fuel pellets for fast flux irradiation studies, 25:58397
CHANG, R. Shihman, Cell line initiation from cord blood leukocytes treated with viruses, chemicals, and radiation, 25:57921
CHANTRY, P. J., Doppler broadening in beam experiments, 25:58752
  Spurious dissociative attachment peaks from inelastic loss reactions, 25:58730
CHAPELOT, A., Phenix reactor, 25:60049
CHAPKIS, Robert L., Theory of cooled spherical electrostatic probe, 25:58982
CHAPLIN, R. L., Complex annealing within stage I of Al, 25:58341
CHAPUIS, A., Pollution of the atmosphere in uranium mines, 25:57564
CHARRIERE, G., Anti-lambda production in K^+p interactions at 8.25 GeV/c, 25:59295
CHASE, Robert L., Segmented gamma ray detector amplifier spectrometer, 25:57757
CHATTERJI, D., Calculated liquidus and solidus curves for the Hf--Zr, Hf--U, and Zr--U systems, 25:58292
CHAUDHURI, Nirmal K., Gravimetric determination of molybdenum(VI) with salicylhydroxamic acid, 25:57308
CHAUDHURI, S. K., Agents protecting skin against acute radiation, 25:58036
CHAULIAGUET, Charles, Double microfield probe, 25:58990
CHECHERNIKOV, V. I., Magnetic properties of Sm--Gd alloys, 25:59176
CHECHKIN, V. V., Low-frequency waves in dense plasma containing two ion species, 25:59093
CHEKA, J. S., New exoelectron dosimeters, 25:57835
CHEKUROV, V. M., Radiosensitivity of wheat, 25:58152
CHELNOKOV, M. B., Determination of parameters of nonequilibrium plasma in a restricted volume allowing for step-wise ionization, 25:59034
  Determination of plasma parameters according to intensity of continuous spectra, 25:58993
  Population of excited atomic states and ionization in a nonequilibrium cesium plasma at low pressure, 25:59008
CHEMTOB, M., Nature of the two-pion exchange contribution to the nuclear force, 25:59870
CHEN, C. W., Radiation damage to the crystalline structure of a glass-forming chalcogenide, 25:58419
CHEN, H. H., T invariance and unitarity limit in K/sub L/$^0 \to \mu^+\mu^-$, 25:59543
CHEN, Kwan-yu, Monochromatic reflection effect of close binary stars, 25:58451
CHEN, R., Neutron-induced mutants of Pisum sativum, 25:57960
CHEN, Wilkie Y. K., Occurrence of superconductivity in simple cubic (Au/sub 1-x/Pd/sub x/)Te_2 alloys, 25:58928 (CALT-822-37)
CHENEBAULT, Pierre, Techniques of continuous measurement of radioactive fission gases evolved in fuel elements, 25:57344 (CEA-R-4218)
CHENG, Y. C., Heat treatment studies of infrared absorption in reactor-irradiated Ge, 25:58343

CHERDANTSEV, P. A., Mass parameter of fission asymmetry, 25:59874
CHERDYNTSEVA, K. V., Complex investigation of extensive air-shower core with energy greater than or equal to 10^{15} eV, 25:59249
CHERKASHIN, V. I., Activity of Al, V, and Cr in binary Ti alloys, 25:58220
CHERNOGUZOV, V. M., Activity of aminotransferase in mitochondria of irradiated animals, 25:57933
CHERNOV, I. G., Charge exchange and transition reactions of a hydrogen atom during collisions of argon ions with water molecules, 25:57460
CHERNOV, V. M., Alloying of Magnico alloy with Nd, 25:58250
CHERNYI, O. V., Recrystallization of copper reinforced with tungsten, 25:58285
CHESSELL, C. I., Calculation of reflection and transmission coefficients for thin highly ionized layers, 25:58869
CHESTER, Marvin, Flow dissipation equation in liquid He II, 25:58927
CHETVERUSHKIN, B. N., Solution of the energy equation and the radiation transfer equation, 25:58851
CHEVLYTKO, A. A., Neurosecretion cells of the dog hypothalamus during acute radiation sickness, 25:58129
CHIBA, Toshinobu, Electron microscopy of hydride precipitation in vanadium, 25:58407
CHIBISOV, M. I., Transitions to the sublevels of the fine and hyperfine structure in the slow heavy-particle atomic collisions, 25:58746
CHIGRINOV, S. E., Statistical reconstruction of inelastic π-N and N-N interactions in the superhigh energy region, 25:59472 (JINR-P2-6022)
CHIN, T. N., Highly excited states seen in reaction $^{12}C(^{16}O,p)^{27}Al$, 25:59714
CHIRIKOV, B. V., Stochasticity in many-dimensional nonlinear oscillating systems, 25:59652
CHIRKOV, V. A., Stabilization of the heat-output field in fast reactors by control elements, 25:60045
CHISHOLM, J. S. R., Algorithms for γ-algebra of electromagnetic form factors, 25:59360
CHIU, Wen Tzong, Mechanism of a rate-controlled cross-disproportionation between phenoxyl radicals, 25:57432
CHIZHIKOV, D. M., Kinetics of the reduction of tungsten and molybdenum trioxides by hydrogen, 25:58189
CHKHEIDZE, I. I., Radicals in γ-irradiated hydrates of cyclic ethers, 25:57465
  Radicals in γ-irradiated hydrates of three-membered cycles, 25:57476
CHKUASELI, Z. D., Properties of dense helium plasma in recombination stages, 25:59016
CHOBAN, E. A., Deep inelastic hadron production in coliding lepton beams, 25:59371
CHOCK, E. P., Resolved fine structure in the magnetic resonance of a localized moment in a metal, 25:59192
CHODOS, Alan, CP-invariance violation as second-order weak effect, 25:59540
CHODURA, R., Asymptotic behavior of the two-stream instability, 25:59062 (IPP-6/97)
CHOI, Young Sung, New immunoglobulin-like molecules in the serum of bursectomized-irradiated chickens (heavy(μ)chain/immunoelectrophoresis/agammaglobulinemia), 25:57934
CHOLLET, J. C., Measurement of $K_2^0 \to 2\gamma$ branching ratio and search for $K_1^0 \to 2\gamma$ decays, 25:59264
CHOLOKOV, K. S., Electric conductivity of electron-irradiated monocrystals of KCl--RbCl solid solutions, 25:59172
CHONG, Claude Y. L., In vivo radiobiological studies of 910 MeV helium ion beam, 25:57997 (LBL-314)
CHOSA, M., γ-radiolysis of gaseous carbon dioxide at high densities, 25:57461
CHOUDHARY, A. R., Uniformization in a soluble partial wave model, 25:59620
CHOWDHURY, A. Roy, Positive width and S-wave scattering length in πlambda scattering in Veneziano model, 25:59473
CHRISTENSEN, J. A., Melting heat rating of UO_2--25 wt. percent PuO_2 fuels, 25:60243
CHRISTENSEN, P., Combined lithium borate and lithium fluoride thermoluminescence dosimeter for routine personal monitoring, 25:57842
CHRISTENSEN, Ralph Chresten, Heavy-ion-induced single- and double-strand breaks in PHIX-174 replicative form DNA, 25:57952 (LBL-28)
CHU, C. N., Heat treatment studies of infrared absorption in reactor-irradiated Ge, 25:58343
CHUDY, M., ^{14}C in atmosphere and biosphere, 25:57364
CHUI, R., Resolved fine structure in the magnetic resonance of a localized moment in a metal, 25:59192
CHUISTOV, K. V., Structure of decomposed Co--Nb alloy, 25:58280
CHURCHWELL, E., Observational evidence for Stark broadening in radio recombination lines, 25:58546
CHWASZCZEWSKA, J., Excitation of isomeric activities in Rb, Y, Pd, Cd, W, Os, and Pb using 14.8-MeV neutrons, 25:59797
CIOCANEL, A., Polarization effects in nuclear transfer reactions, 25:59831 (IFA-CRD-41)
CIOFI DEGLI ATTI, C., Comparison of Brueckner and Jastrow methods in electron scattering, 25:59704
  High-energy electron and proton scattering and deformation of ^{12}C nucleus, 25:59729
CISSOKO, M., Detonation waves in relativistic magnetohydrodynamics, 25:59043
CIZERON, G., Aging of ternary Fe--Ni--Mo and quaternary Fe--Ni--Co--Mo alloys, 25:58232
CLARK, C. D., Radiation-induced defects in diamond, 25:59137
CLARK, R. M., Interaction of internal gravity waves with the F2 layer, 25:58872
CLARKE, James H., Reaction matrix method for computing probabilities of vibration--translation energy transfer, 25:58762
CLARKE, John, Impedance matching Josephson galvanometer by means of superconducting transformer, 25:58938
CLARKE, John Stephen, Collective modes in Fermi liquids, 25:58920
CLAYTON, D. D., Pulsations of massive main-sequence stars, 25:58434
CLAYTON, J., Annihilation process p anti p $\to 2\pi^+2\pi^-$ at 2.5 GeV/c, 25:59271
CLEMENT, David M., Harmonic oscillator potential insertions in particle lines, 25:59862
CLERC, Rene-Louis, Trajectories equations in a space with a nonriemannian connection, 25:59598
CLEYMANS, J., Veneziano-type representations of the pion form factor and couplings of photons to heavy vector mesons, 25:59352
CLIFFORD, C. E., Experimental investigation of neutron streaming through the grid-plate shield of the fast flux test facility, 25:60158 (ORNL-TM-3514)
  Prog. rpt. on fast reactor shielding, 8/71, 25:60055 (ORNL-TM-3573)
CLIFFT, R. W., Real part of the rho--nucleon forward scattering amplitude and the relative rho--ω production phase, 25:59252
CLIFTON, J. J., Removal and replacement of boiling channels on prototype SGHWR, 25:60079
CLINE, D., K^+N charge-exchange reaction at 5.5 GeV/c, 25:59305
CLOPP, H. W., Observation of new K/sub N/(1760) in $K\pi$ and $K\pi\pi$ systems, 25:59318
CLOSE, F. E., Nonleading Regge behavior in νW_2 and the possibility of fixed poles with polynomial residues, 25:59381
COAST, Geoffrey, Heat engine plant, 25:60027
COATS, R. B., Electromagnetic interactions of cosmic-ray muons at large zenith angles at sea level, 25:59343
COCKE, W. J., Oscillation in optical and x-ray flux from Scorpius X-1, 25:58535
COHEN, C., Atomic displacements in He^+-irradiated Si and a Si--Ge alloy, 25:59136
COHEN, Herschel, Effect of intermolecular forces on the neutron scattering spectrum of simple fluids, 25:59678
COHEN, Karl, Review of fast reactor operating experience, 25:60094 (CONF-710922-2)
COHEN, Martin, Two young bright infrared objects, 25:58505
COHN, S. H., Whole-body counter for neutron activation analysis, 25:57785
COLCHIN, R. J., Target plasma trapping, 25:58969
COLE, J., Particle momentum distributions for 8.5-GeV/c π^+p interactions, 25:59317
  Strangeness-changing leptonic decay rates for Σ^+-hyperons, 25:59261
COLE, K. D., Thermospheric winds induced by auroral-electrojet heating, 25:58864
COLEMAN, C. J., Simple relativistic theory of gravitation, 25:59590
COLEMAN, J. A., Electron radiation damage effects in silicon surface-barrier detectors, 25:57907
COLES, Harold John, Improvements in or relating to heat exchangers, 25:57630
COLLERAINE, Anthony P., Fusion reactions in self-colliding orbits, 25:59078
COLLINS, C. B., Qualitative cosmology, 25:58669
COLLINS, E. D., Summary of the campaign during February 1969 to process six irradiated HFIR targets in the transuranium processing plant, 25:57524 (ORNL-TM-3343)
COLLINS, P. A., Generalized Veneziano model for $\pi^-p \to K^0$ anti K^0n, 25:59492
COLOMBO, L., Use of radioactive tracers in the study of breast cancer, 25:58051
COLVIN, R. S., Absorption-line study of galactic H at 21 cm, 25:58651
COLWELL, Jack H., Equivalence of the superconducting transition temperature of pure indium as determined by electrical resistance, magnetic susceptibility, and heat-capacity measurements, 25:58949
COMBET-FARNOUX, F., Determination of photoionization cross sections in various atomic models, 25:58684
COMMON, A. K., Constraints imposed on $\pi^0\pi^0$ s- and d-waves by analyticity, crossing, and positivity, 25:59458
COM-NOUGUE, J., Does oxidation of Zr obey Wagner's theory, 25:58254
COMPTON, S. J., Tools and recovery equipment, 25:60107
CONDE, H., Prompt anti ν in spontaneous and neutron fission of ^{236}U, 25:59806
CONEN, Patrick E., In vitro chromosomal radiosensitivity in Fanconi's anemia, 25:57973
CONETTI, S., Comparison of high-energy hadron--deuteron scattering data with Glauber model, 25:59269
CONFORTO, B., Improved partial wave analysis of anti KN $\to$ anti KN from 800 to 1200 MeV/c, 25:59293

CONNER, William V., Preparation of actinide metal targets using special casting techniques, 25:59634 (CONF-711002-, pp 59-69)
CONSTANTINESCU, F., Storage behavior of sintered uranium oxides, 25:58371
COOK, G., Uranium geochemistry of the Gulf of Mexico, 25:57587
COOK, Reginald Kenneth, Fluid-cooled nuclear reactor, 25:60073
COOPER, G., Forming processes for metal matrix composites, 25:58363
COOPER, J. R., Some (n,p) cross-sections of ^{46}Ti, ^{47}Ti, and ^{48}Ti, 25:59755
COOPER, W. A., Precision measurement of lifetime and decay branching ratio of Λ^0 hyperon, 25:59260
COPELAND, G. L., Experimental investigation of fabrication of Th--20 wt. percent U for the UMBR fuel element, 25:58185 (ORNL-TM-3499)
CORBELLA, Oscar D., L-wave inverse scattering problem, 25:59623
CORDFUNKE, E. H. P., Sodium uranates: preparation and thermochemical properties, 25:57405
CORDS, D., Observation of new K/sub N/(1760) in Kπ and K$\pi\pi$ systems, 25:59318
COREY, B. E., Coincidence study of reaction ^{2}H(d,dp)n, 25:59699
CORMIER, T. M., Highly excited states seen in reaction ^{12}C(^{16}O,p)^{27}Al, 25:59714
CORNGOLD, Noel, Some analytical methods in neutron transport theory, 25:59682
CORNUAULT, P., Development of properties of nuclear graphite obtained by a mixture of cokes, 25:58366 (CEA-CONF-1820)
CORNWELL, D. T., Six pion amplitude to fourth order in momenta, 25:59456
  Soft pion--pion scattering to fourth order in momenta and effective chiral Lagrangians, 25:59455
COSMAN, E. R., Highly excited states seen in reaction ^{12}C(^{16}O,p)^{27}Al, 25:59714
COSTA, Augusto A. F., Thermodynamic behavior of the ''multiflash'' evaporator, 25:57616 (LFEN-NI.-54-a)
COSTA, L., β and γ activity of fission products of ^{235}U and ^{239}Pu. II, 25:59813
COSTA, Paul, Stress changes in Ta carbide with deformation rate and temperature (1,200 and 2,200°C), 25:58395
COSTELLO, D. G., Application of photoinduced reactions to nuclear materials safeguards problems. Project summary report, July 1, 1970--June 30, 1971, 25:57704 (GULF-RT-A-10826)
COSTRELL, Louis, CAMAC instrumentation system: introduction and general description, 25:57883
COUCH, W. E., Radiation scattering in Einstein--Maxwell theory, 25:59606
COUCOURDE, F., Clinical and technical observations in therapy with 42 MeV betatron, 25:58076
COUNSELMAN III, C. C., Crab Nebula pulsar radio pulse arrival times, 25:58559
COUSSEINS, J. C., TlF--UF$_4$ system, 25:58418
COUTTS, Christine, Faint supernova in an anonymous southern galaxy, 25:58455
COX, D. P., Reduced helium abundances in nebulae, 25:58446
COYNE, D. G., π^+p elastic scattering at 3.6 GeV/c, 25:59292
CRAFT, T. F., Synergistic treatment of textile dye wastes by irradiation and oxidation, 25:57452
CRAMPTON, David, Wolf--Rayet stars in H II regions, 25:58477
CRANDALL, R. S., Surface-state lifetimes and current flow in liquid helium, 25:58911
CRASE, K. W., New exoelectron dosimeters, 25:57835
CRAWLEY, G. M., High-resolution 5000μ silicon surface-barrier detectors, 25:57801
CRISTEA, M., Dielectric permittivity of a weakly ionized plasma placed in crossed fields, 25:59050
CROSETTI, P. A., Systems approach to nuclear plant protective systems data program, 25:60208
CROSETTI, Paul A., Fault tree analysis with probability evaluation, 25:60133
CROSIGNANI, B., Equation of motion for P representation, 25:59208
CROUSE, D. J., Radioactive contamination of copper recovered from ore fractured with nuclear explosions, 25:57523 (ORNL-4677)
CROUTHAMEL, C. E., Chemical Engineering Division. Cross sections and burnup semiannual report, January--June 1971, 25:60035 (ANL-7824)
CROWLEY, B. K., Analysis of Jorum containment, 25:57607
CROWTHER, Russell Lee, Nuclear reactor fuel assembly, 25:60247
CRUBELLIER, A., Application of the factorization method and group theory to the relativistic treatment of hydrogenic radial functions, 25:58821
  Study of (d + x)/sup n/p/sup m/ configurations using the SU$_3$ group, 25:58787
CRUDDACE, Ray, Evidence for a highly compact x-ray source, 25:58534
CSIKOR, F., Veneziano model for process A/sub μ/π $\rightarrow$ A/sub μ/π, 25:59464
CSONKA, Paul L., Introduction to x-coefficients and a tabulation of their values, 25:59881
CULHANE, J. L., Helium-like line-emission coronal features, 25:58621
CUMO, M., Measurement of the effect of twisted tapes on the forced-convection heat transfer and burnout in heat exchangers, 25:57643
CUNNINGHAM, B. B., New high-temperature phase of protactinium metal, 25:58291
CUNNINGHAM, P. T., Prog. rpt. on physical chemistry of liquid metals and molten salts, semiannual, 1--6/71, 25:58387 (ANL-7823)
CURATOLO, M., Transverse waves and instabilities in a uniform plasma for propagation along the magnetic field, 25:59102
CURRIE, R. L., Static and pulsed reactivity measurements on large ^{235}U fuel forms in water, 25:60212
CURTISS, C. F., Low-energy atomic collisions. II, 25:58771
CUSSENOT, J. R., Measurement of parameters of Ce plasma, 25:58986
CZARNECKI, J., Simplified method of analytical determining the coefficient of increase for gamma radiation, 25:57681
CZEGLEDY, Sandor, Applications of the channelling and blocking effects, 25:59151
CZERNICHOWSKI, A., Interaction of argon and neon plasmas in pseudo equilibrium with additions, 25:59018
  Interferometric determination of temperature in a laminar jet of argon or neon plasma, 25:58984
  Spectral diagnostics of argon and neon plasmas in pseudo equilibrium, 25:58991
CZUBEK, Jan A., Pulsed neutron method for uranium well logging, 25:57560 (INP-732)

D

DABROWSKI, J., Binding energy of ^{3}H and n--d doublet scattering length with rank-four separable potential, 25:59707
DABURON, F., Serum concentrations of immunoglobulin in pigs after exposure to γ ray, 25:58104
DADASHEV, L. A., Some properties of Lee model. I, 25:59575
D'ADDA, A., Zeros of dual resonant amplitudes, 25:59625
DAFT, M., Diffusion of Co in Pu, 25:58212 (NRCN-268)
DAGAZIAN, R. Y., Kinks and tearing modes in simple configurations, 25:59068
DAHLKE, Lutz W., Development of a method of neutron radiography of mixed oxide fuels using radiographic analogs, 25:57698
DAIBOG, E. I., Angular distribution of particles produced in multiple processes, 25:59327
D'ALELIO, Gattano Francis, Highly radiation-sensitive amides, 25:57451
DALGARNO, A., He$^+$/H$^+$ concentration ratios in H I regions, 25:58630
DALITZ, R. H., Some problems with the quark model for elementary particles, 25:59437
DAL'KAROV, O. D., New type of baryon resonances, 25:59500
  Possibility of observing quasinuclear meson resonances in colliding e$^+$e$^-$ beams, 25:59358
DALPIAZ, P., Evidence for decay mode $X^0 \rightarrow \gamma\gamma$ and determination of branching ratio $X^0 \rightarrow \gamma\gamma/X^0 \rightarrow$ total, 25:59290
DALTABUIT, E., Reduced helium abundances in nebulae, 25:58446
DANILOV, A. D., Studies of atmosphere and ionosphere at times of unusual solar activity, 25:58893
DA PROVIDENCIA, J., Theorem for energy-weighted averages of spectroscopic factors, 25:59855
DAS, Jyotirmoy, Gravimetric determination of molybdenum(VI) with salicylhydroxamic acid, 25:57308
DAS, T. P., Many-body theory for hyperfine effects in atoms and molecules, 25:58794
DA SILVA, C. Pacheco, Techniques for preparation of UO$_2$--niobium (or molybdenum) cermets, 25:58348 (LFEN-NI.-53-a)
DATIN, J. T., Experimental study of ω neutral decays, 25:59320
DAUKNIS, V. I., Statistical methods of determining the thermal-shock resistance of refractories, 25:58376
DAUKSCH, Helmuth, Surface changes in carbon fibers during graphitization, 25:58382
D'AURIA, R., Zeros of dual resonant amplitudes, 25:59625
DAVIDOV, D., Resolved fine structure in the magnetic resonance of a localized moment in a metal, 25:59192
DAVIDSON, Daniel Fraser, Improvements in or relating to flow pressure measurement, 25:57646
DAVIES, J. A., Channeling-effect technique for studying atomic locations within the crystal lattice, 25:59167
  Introduction to ion implantation, 25:59166
DAVIES, J. M., Electron irradiation of dilute aqueous solutions of polymers, 25:57443
DAVIES, K. H., International survey of the operation of dc electrostatic particle separators, 25:59644 (RHEL/R-222)
DAVIES, W. G., Charge-exchange and/or knockout spectator poles in reaction D(^{3}He,tp)p, 25:59694
DAVIS, Beth O., Structure of the southeastern Mississippi region, 25:57596 (USGS-474-129)
  Velocity cross section 5, extending southwest from Tatum dome, Lamar County, Miss, 25:57595 (USGS-474-112)
DAVIS, Cecil G. Jr., Radiative-transfer effects in Cepheid

atmospheres, 25:58474
DAVIS, Dennis, Nuclear reactor control system, 25:60054
DAVIS, J. R., Resonances in the ^{29}Si(p,γ)^{30}P reaction, 25:59760
DAVIS, K. H., Phenomenology of muon showers underground, 25:59247
DAVIS, M. H., Laboratory quality control computer program, 25:57611 (CTC-51)
DAVIS, W. R., General formulation of tetrad variational principle of Einstein's gravitational theory, 25:59600
DAVISON, P. J. N., Spectrum and galactic isotropy of diffuse cosmic x rays, 25:58650
DAVYDOV, A. V., Extraction of protactinium and its analogs from solutions of oxalic and tartaric acids with tributylamine, 25:57546
DAWSON, J. M., Use of long-wavelength, high powered lasers for controlled thermonuclear fusion, 25:59054 (MATT-782)
DAY, D. H., Studies of vibration spectra of bonded hydrogen atoms using a pulsed neutron source, 25:58384
DAYBELGE, Umur, Electrical conductivity in toroidal plasma with trapped particles, 25:59046
DEAN, N. W., Simple relations among multiple scattering amplitudes in light nuclei, 25:59524
DEANGELIS, Umberto, Small clusters of galaxies and the mass-to-light ratio, 25:58643
DE BAERE, W., Six- and seven-body final states in K$^+$p interactions at 5 GeV/c, 25:59299
DEBAISIEUX, J., Six- and seven-body final states in K$^+$p interactions at 5 GeV/c, 25:59299
DE BOELPAEPE, Robert, Spontaneous somatic recombinations in a Nicotiana xanthi nc mutant and their induction by γ radiation, 25:57977
DE BOER, J., E4 moments in ^{152}Sm and ^{154}Sm, 25:59823
DE BROGLIE, Louis, Motion of a particle in a refracting medium, 25:59325
DEBUIGNE, J., Kinetics of zirconium oxidation under low oxygen pressures, 25:58175
DECARLO, V. A., Neutron-capture-γ ray spectrum calculations for materials for possible use in a ^{252}Cf neutron activation facility, 25:57796 (ORNL-TM-3457)
DECHAMPS, M., Kinetics of zirconium oxidation under low oxygen pressures, 25:58175
DE CHOUDENS, H., Dosimetric applications of EPR measurements of free radicals formed in amino acids, 25:57852
DECOWSKI, P., Cross sections for reactions ^{89}Y(n,n')/sup 89m/Y and ^{89}Y(n,2n)^{88}Y, 25:59768
DE GOEIJ, J. J. M., Mercury in the environment, 25:57392
DEGRANGE, B., Heavy liquid bubble chamber analysis of eta^0 neutral decay modes, 25:59244
DE HEEM, L., Development of breeder reactors in European community, 25:60032
DEHM, G., Application of unitarized Veneziano model to reaction K$^+$n → K$^+\pi^-$p at 3 GeV/c, 25:59478
DEHOFF, R. T., Prog. rpt. on quantitative determination of the structure-property relationships in nuclear fuel element materials, 3/15/71--6/15/71, 25:58389 (SRO-552-8)
DE JONGHE, L. C., Dislocation contrast at high voltages, 25:60292 (UCRL-20700)
DEKANENKO, V. M., Oxidation of niobium containing oxygen, 25:58172
DEKNUDT, Gh., Chromosome aberrations in persons exposed chronically to ionizing radiations, 25:57972
DELAND, F. H., Rectilinear scanning, 25:58057
DE LA RENAUDIERE, J. F., Radiolytic formation of long-lived ammoniated electrons, 25:57477
DELHAES, Pierre, Specific heat of neutron irradiated graphite between 1.4 and 4.4°K in presence of a variable magnetic field (0 to 40 kGs), 25:59148
DELISLE, J. P., Phenix reactor, 25:60077
DE LORENZO, J. T., Low-noise, wide-band, current-pulse preamplifiers for neutron counters, 25:57751
DE LOS ANGELES GALINDO BECERRA, Ma., Dosimetry of ionizing radiation on Drosophila melanogaster, 25:57999 (NP-18944)
DE LUCIA, Frank C., Rotational spectra of NH_3 and ND_3 in the 0.5-mm wavelength region, 25:57424
DELWAIDE, P. A., Liege anthropogammameter and its clinical use, 25:57764
DEMCHENKO, V. V., Propagation of TM waves in magnetoactive plasma, 25:59094
DE MEESTER, P., Purification of vanadium and production of vanadium single crystals through zone melting, 25:58192
DEMEKHINA, N. A., Nuclear photofission cross sections for photon energies up to 5 GeV, 25:59794
DEMIRKHANOV, R. A., Influence of high-frequency potential of a toroidal electric field on the trapping of charged particles in a closed magnetic trap, 25:58976
DEMPSTER, A. B., Normal coordinate analysis of ethyl chloride and some deuterated derivatives, 25:57422
DEMSOREANU, Brutus, Mass of muon neutrinos, 25:59257
DEMYANTSEVICH, V. P., Effects of composition of hardfacing alloys on their hardness, 25:58235
DENGEL, O. H., Activation analysis of sodium and potassium in solid propellants, 25:57384
DEN HOLLANDER, W., Device for the safe handling of tritium gas, 25:57502
DENIS, J., Second-order rotational perturbation of nonradial oscillations of a star, 25:58441
DENISOV, S. P., Experimental comparison of anti dp and anti pd total cross sections, 25:59275
DE NOVION, C. H., Magnetic specific heat and spin disorder resistivity of UN, 25:59180
DEO, P. G., Immunity developed in chickens using irradiated eggs, 25:57946
DEPORTES, C., Electric conductivity of solid solutions of $(ThO_2)_{0\ 75}$--$(CeO_2)_{0\ 25}$ at high temperature, 25:58368
DE RAFAEL, E., Neutral kaon decays into muon pairs and violation of CP invariance, 25:59544
DEREM, Andre, Spin amplitudes in spin-$^1/_2$ scattering, 25:59471 (CEA-N-1456)
DERGUNOVA, V. S., Influence of the nature of a graphite lattice on the rate of impregnation by molten zirconium, 25:58245
DERLIKOWSKI, Jerzy, Changes of Dextran 40000 irradiated with γ radiation, 25:58160
DESCHIZEAUX, M. N., Gadolinium magnetic equation of state near Curie point, 25:59181
DESCLAUX, J. P., Eigenfunctions of angular momentum operators in J--J coupling, 25:58801
DESCOURS, S., Dosimetric applications of EPR measurements of free radicals formed in amino acids, 25:57852
DESESQUELLES, J., Polarization of H/sub β/ line emitted in Li$^+$ + H_2 collisions, 25:58780
DESHA, David Lawrence, Participation of x-rayed cells in regenerate induced on x-rayed limb of salamander, 25:58103
DESHAYES, Alain, Spontaneous somatic recombinations in a Nicotiana xanthi nc mutant and their induction by γ radiation, 25:57977
DE STEESE, J. G., Thermionic energy conversion system design, 25:57656 (N-71-18512)
DETAR, C. E., Sum rules for inclusive cross sections, 25:59331
DE TOURREIL, R., β and γ activity of fission products of ^{235}U and ^{239}Pu. II, 25:59813
DETTMANN, Klaus, High-energy treatment of atomic collisions, 25:58775
DE VAUCOULEURS, A., Photometric observations of supernova 1971 in NGC 4165, 25:58464
DE VAUCOULEURS, G., Photometric observations of supernova 1971 in NGC 4165, 25:58464
DEVELEY, G., Gadolinium magnetic equation of state near Curie point, 25:59181
DEVENSKI, P. A., pp and pd elastic scattering at 50 and 70 GeV, 25:59273
DEVINNEY, E. J., Possible black hole in beta Lyrae, 25:58497
DE VOLPI, A., Deadtime correction in counting rapidly decaying sources, 25:57732
DEVORET, Raymond, Conjugal transfer of uv-damaged F-prime sex factors, 25:57956
DEVRIES, Ralph M., Reaction (p,^{4}He) mechanisms in light nuclei, 25:59711 (UCLA-10-P-18-32)
DE WOLF, E., Six- and seven-body final states in K$^+$p interactions at 5 GeV/c, 25:59299
DHAWAN, Satish, Yale--NAL CAMAC system, 25:59658
DHOPESHWARKAR, G. A., Fatty acid transport into the brain, 25:60290 (UCLA-12-839)
DIAMANT-BERGER, A., Determination of low-energy π--π phase shifts and form factors in K/sub e4/$^+$ decay, 25:59263
DIAMOND, R. M., E4 moments in ^{152}Sm and ^{154}Sm, 25:59823
DIBOS, P. E., Study of the reticuloendothelial system in hematological diseases, 25:58053
DI CASTRO, C., Explicit examples of off-diagonal long-range order, 25:58918
DICKEL, Helene R., Search for southern OH--ir objects, 25:58466
DICKENS, J. K., Elastic scattering of 40-MeV protons from ^{48}Ti, /sup nat/Cr, and ^{64}Zn: tabulated differential cross sections, 25:59739 (ORNL-TM-3591)
DICKENS, R. J, Effective temperatures and gravities for A- and F-type stars, 25:58476
DI GUGLIELMO, L., Clinical and technical observations in therapy with 42 MeV betatron, 25:58076
DIKAYA, K. I., Properties of ceramic coatings of phosphate ceramics, 25:58375
DI MAGGIO, Diassina, Survival of E. coli B/r after x irradiation, 25:58155
DIMITROV, C., Effect of impurities on recovery of Al irradiated with fast neutrons, 25:58303
DIMITROV, O., Effect of impurities on recovery of Al irradiated with fast neutrons, 25:58303
DIMOV, V. I., Formation of braking radiation beam of medical betatron, 25:59651
DIN, G. U., Resonances in the ^{29}Si(p,γ)^{30}P reaction, 25:59760
DI NAPOLI, Vito, Fragment yields for the fission of ^{209}Bi induced by a 1000-MeV bremsstrahlung, 25:59816
DINARDO, R. P., Transition radiation and optical properties of evaporated carbon foil, 25:58686
DI PORTO, P., Equation of motion for P representation, 25:59208
DIPPEL, Th., Manufacturing of fuel pellets with center holes, 25:58362
DIRIAN, Gregoire, Method and apparatus for the purification of heavy water, 25:57545
DIRKS, Johan Francis, Generalized variational bounds on the positron-hydrogen reaction matrix, 25:58755
DITTRICH, Walter, Eikonal formulation in neutral scalar

field thecry, 25:59569

DJADALI, Fayegh, Measurement of the circular polarization of γ radiation after capture of polarized thermal neutrons in nuclei, 25:59780 (KFK-1401)

DJERASSI, Henri, Study of electrical conductivity and thermoelectric power of uranium dioxide UO/sub 2+x/ at high temperatures, 25:59191

DJORDJEVIC, O., Biological dosimetry methods, 25:58018

DJUKIC, Z., Biclogical dosimetry methods, 25:58018

DMITRENKO, D. A., Radio intensity of Virgo A in 10 to 30-cm range, 25:58525

DMITRENKO, L. V., Radio intensity of Virgo A in 10 to 30-cm range, 25:58525

DMITRIEV, I. S., Electron loss and capture cross sections for multiply charged ions in solid matter, 25:58695

DMITRIEV, S. P., Device fcr connecting the generator tube with the resonance system of a synchrocyclotron, 25:59649

DMITRIEV, V. F., Electroproduction of pions on nuclei in bound states, 25:59355

DMITRIEV, V. M., Nonisothermal superconducting bolometer. II, 25:58952

DMITRIEVSKII, I. M., Study of a tissue-equivalent spherical proportional counter, 25:57853

DOBROLYUBSKAYA, T. S., Conditions for the luminescence determination of uranium in silicon dioxide of high purity, 25:57328
  Formation of hydrates of U(VI), Gd, and Tb peroxides under acticn of ultraviolet light, 25:57416

DOBROWOLSKI, Jan, Determination of silicon in pure tellurium, 25:57324

DOBRY, H., Computer program for determination of isodose curves for electron energies from 5 to 42 MeV, 25:58009
  Computer programs for irradiation planning in high-energy therapy, 25:58021
  Computer programs for irradiation planning in high-energy therapy, 25:58008
  Computer programs for irradiation planning in high-energy therapy, 25:58020

DOCHERTY, J., Surface dosimetry using thermoluminescent discs, 25:57837

DOCTOR, Z. K., Substoichiometric determination of nickel in steel by neutron activation analysis, 25:57381

DODSON, Ronald F., Electron microscopic observations of rat medullary reticular tissue after short-term, whole body gamma irradiation, 25:58118

DOHNALOVA, E., Use of Ross filters in radioisotope x-ray flucrescence determination of iodine in drugs, 25:57322

DOI, Kazuyori, Real time reactor simulation on a hybrid computer, 25:60218

DOINIKOV, N. I., Modified scalar potential in boundary-value problems in magnetostatics, 25:59647

DOKSHINA, G. A., Action of gamma radiation on the adrenal cortex and thyroid gland in the rat, 25:58107
  Radon irradiation of rat tissue and organs, 25:57932

DOLAN, J. F., Eclipsing binary model of Cygnus XR-1, 25:58553

DOLENKO, Anatoly Vasilievich, Determining the content of chemical elements or isotopes thereof in a specimen by utilizing the effect of recoilless resonance absorption or scattering of gamma rays, 25:57354

DOLGINOV, A. Z., Cosmic electron acceleration and the spectrum of metagalactic x rays, 25:58830

DOLGOPOLOV, V. V., Characteristics of collisionless damping of electromagnetic wave in a region of intense inhomogeneity of a cold plasma, 25:59081 (AEC-tr-7272)
  Propagation of TM waves in magnetoactive plasma, 25:59094

DOLIN, P. I., Pulse-radiolysis studies of some nucleic acid fragments in aqueous solutions, 25:57930

DOLNICK, Carl L., Polarization and differential cross section for reaction $pp \to \pi^+d$ at 425 MeV, 25:59270

DOLPHIN, G. W., Use of radiation-induced chromosome aberrations in human lymphocytes for dosimetry, 25:58014

DOMANSKI, Tomislaw, Method for determining the mass of dust deposited on membrane filters by measurements of the absorption of beta rays, 25:57870

DOMBROWSKI, C. S., Whole-body counter for neutron activation analysis, 25:57785

DOMENICO, B. A., Application of generalized Newton--Raphson method in radiative-transfer problems, 25:59041

DOMINGUEZ, C. A., Axial-vector form factors from current algebra Regge poles and Veneziano model, 25:59356

DONATO, A., Gaseous RuO_4 removal by ferric oxide-silica filters, 25:57532

DONINI, E., Some consequences of the asymptotic scaling assumption, 25:59342

DONLON, Terrence Edward, Kinetics of rejoining of single-strand breaks induced by ionizing radiation in DNA of human lymphocytes, 25:57958

DONNET, J. B., Surface changes in carbon fibers during graphitization, 25:58382

DONOGHUE, T. R., Polarization transfer in reaction $T(p,n)^3He$ at 0° for E/sub p/ in range 3 to 16 MeV, 25:59695

DONSKOV, S. B., Experimental comparison of anti dp and anti pd total cross sections, 25:59275

DONTSOVA, S. G., Conditions for formation of omega phase in alpha + beta Ti alloys, 25:58283

DOODY, A., Operant behavior of pre- and post-pubertal rats irradiated with ^{131}I, 25:58100

DORAN, D. G., Comparison of displacement rates produced by ion bombardment and neutron irradiation, 25:59144

DORE, Earl K., Comparison of radioaerosol versus radioxenon inhalation procedures in obstructive lung disease and pulmonary embolism, 25:58040 (UCLA-12-834)

DOROFEEV, G. A., IAEA international glass dosimetry intercomparison, 1970, 25:57838

DORRI, M. Kh., Protection against reactor emergencies associated with reactivity perturbations, 25:60123

DORY, R. A., Containment in Tokamak and bumpy torus, 25:58961 (CONF-711016-1)
  Proposal for computer assisted data acquisition for ORNL fusion experiments, 25:59075 (ORNL-TM-3593)

DOST, M., Coulomb excitation of Pb isotopes with α and ^{16}O beams, 25:59804

DOUBLAS, Richard F., Sedimentary uranium deposits, 25:57584

DOUGAL, A. A., Plasma diagnostics utilising optical interferometry and holographic techniques, 25:59001

DOUGLASS, D. L., Diffusion of oxygen in zirconia as a function of oxygen pressure, 25:58370

DOUSTE-BLAZY, Louis, Effect of γ radiation on phospholipase A activity of Sticker sarcoma, 25:57940

DOVBISHCHUK, M. N., Effect of heating by glow discharge on the physico-chemical surface condition of solid alloys, 25:58233

DOVER, C. B., Calculation of the pion--nucleus optical potental, 25:59516

DOWNES, D., Compact radio sources in the galactic nucleus, 25:58555

DOYAS, R. J., Evaluated nuclear cross section library, 25:59783 (UCRL-50400(Vol.4))

DOYLE, A. E., Double-isotope derivative plasma assay for noradrenaline and adrenaline, 25:57914

DRAPER, E. Linn Jr., Integral reaction rate determinations. Part I. Tailored reactor spectrum preparation and measurement, 25:60163

DRENSKA, S., Classification and mass formulas for mesons in ladder U(6,6) symmetry, 25:59546

DREPPER, H., Radionecrosis of the skin, 25:58038

DREVILLON, B., Study of anti pp annihilation at 2.5 GeV/c with production of two kaons in final state, 25:59272

DREXLER, G., Absolute measurement of fluence and flux density of low-energy X- and γ-fields by semiconductor detectors, 25:57768
  Energy calibration of dosimeters for gamma and x-rays, 25:57859

DRIJARD, D., Anti-lambda production in K^+p interactions at 8.25 GeV/c, 25:59295

DRIVER, C., Electroproduction of π^0-mesons on protons in backward direction, 25:59353

DROPESKY, B. J., Nuclear chemistry program for Los Alamos Meson Physics Facility, 25:59642 (LA-DC-12795)

DROSG, M., Proposal of a unique nomenclature for voltage comparing ADC's, 25:57886

DRUKAREV, G. F., Excitation and ionization of atoms by electron and proton impact: approximate expressions and scaling relations for the cross sections, 25:58740

DRUMMOND, W. E., High purity germanium radiation detectors, 25:57811

DRUMMOND, William Eric, Characteristics of high purity germanium and silicon radiation detectors, 25:57762

DRYAKINA, I. P., Milling of high-temperature Nb alloy, 25:58158

DUBEN, Anthony Joseph, First order density matrices from configuration interaction wavefunctions for H_3^+, 25:58712

DUCKWORTH, F. C., On the limitations of the method of least squares for the treatment of certain types of data, 25:58301 (RD/B/N-1971)

DUDEK, A., Inelastic effects in the $^{20}Ne(d,^3He)^{19}F$ reaction, 25:59758

DUDEROV, Yu. G., Thermal conductivity of ceramics based on boron nitride and aluminum nitride, 25:58385

DUDEY, N. D., Chemical Engineering Division. Cross sections and burnup semiannual report, January--June 1971, 25:60035 (ANL-7824)

DUDKIN, V. E., Nonrelativistic particles produced in interactions of multicharged cosmic ray nuclei with light nuclei of emulsion, 25:59274

DUDZIAK, Donald J., ENDF formats and procedures for photon production and interaction data, 25:59838 (LA-4549)

DUERR, G., Depth distribution of characteristic x-ray production in Cu by 12- to 30-keV electrons, 25:58685

DUFAYET, Jean-Pierre, Method of nondestructive testing by eddy currents of electricity-conducting tubes and corresponding apparatus, 25:57692

DUFFEY, D., Comparison of stainless steel and Zircaloy-2 as encapsulation materials for ^{252}Cf, 25:58242

DUGNANI LONATI, R., Setting-up of a neutron dosimeter using ionographic tracks in an insulating solid, 25:57856

DUHAMEL, G., Elastic and inelastic scattering of 80-MeV deuterons, 25:59754

DUJARDIN, Roger, Method of nondestructive testing by eddy currents of electricity-conducting tubes and corresponding apparatus, 25:57692

DUKHOVSKOI, I. A., Investigation of reaction $\pi^-p \to pX^-$ at momentum of 3.25 GeV/c with high momentum transfer, 25:59312

DULIEU, Hubert, Spontaneous somatic recombinations in a Nicctiana xanthi nc mutant and their induction by γ radiation, 25:57977
DULIS, E. J., New tin--titanium alloy, 25:58234
DUNCAN, A. J., Low-frequency waves and instabilities in a magnetoplasma, 25:59072
DUNCAN, D. W., Enhancing bacterial activity in a uranium mine, 25:57582
DUNHAM, T. E., Effect of deformation on ThO_2 particle morphology in W--1 wt. percent ThC_2 materials, 25:58264
DUNLAP, H. L., Disorder produced in SiC by ion bombardment, 25:59171
DUNN, Eleanor D., Prog. rpt. on medium-energy physics program, 7/71, 25:59641 (LA-4753)
DUNN, Floyd E., Formulation and application of analytic representations of fast reactor flux and importance spectra, 25:60211 (RPI-328-189)
DUNN, P. D., Properties of a high-current discharge in alkali-metal-seeded rare gases, 25:59023
DUNWOODIE, W., Anti-lambda production in K^+p interactions at 8.25 GeV/c, 25:59295
DUPREE, A. K., Electron densities derived from line intensity ratios: beryllium isoelectronic sequence, 25:58599
DURET, M. F., Plutonium production in NPD: comparison between experiment and calculation, 25:60093 (AECL-3995)
Plutonium recycle in CANDU-type PHW heavy water reactors, 25:60092 (AECL-3910)
DURGAPRASAD, N., Relative abundances of isotopes of light nuclei in primary cosmic radiation, 25:58833
DURRANI, S. A., Ivory Coast microtektites, 25:57565
DUSMATOV, V. D., Determination of tantalum in sphere by activation analysis, 25:57371
DUTEIL, P., Coulomb-nuclear interference in π^---^{12}C elastic scattering, 25:59713
DUTHLER, Carl James, Dependence of He II film transfer rate on pressure head, film height, and substrate, 25:58922
DUTTA, C. M., Many-body theory for hyperfine effects in atoms and molecules, 25:58794
DUTTA, N. C., Many-body theory for hyperfine effects in atoms and molecules, 25:58794
DUYCKAERTS, G., Acidic organodiphosphorus extractants. V, 25:57544
Dissociation constants of double complexes of type MeY_2H/sub n//sup (3-n)/-, 25:57537
Electrochemistry of Pu(III) in molten LiCl--KCl eutectic, 25:57420
DYER, K. F., Effect of radiation on small competing populations of Drosophila melanogaster. IV. Changes in longevity, 25:57961
DZHELEPOV, B. S., Energy tables for gamma ray emission during radioactive decay, 25:59785
DZHEMARD'YAN, Yu. A., Use of (p,γ) reaction to determine light-element content in thin surface layers, 25:57396

E

EARGLE, D. Hoye, Structure of the southeastern Mississippi region, 25:57596 (USGS-474-129)
Velocity cross section 5, extending southwest from Tatum dome, Lamar County, Miss, 25:57595 (USGS-474-112)
EBERHART, J. G., Prog. rpt. on physical chemistry of liquid metals and molten salts, semiannual, 1--6/71, 25:58387 (ANL-7823)
EBERSBACH, H. G., Complex automation of nuclear power plants, 25:60048
EBERT, R., Carnot cycles for general-relativistic systems, 25:58673
ECCLES, D., Semiannual variation in height of F2-layer peak, 25:58879
ECKL, W., Spectra and conversion factors of neutron calibration sources, 25:57676
EDENS, D. J., Inelastic effects in the $^{20}Ne(d,^{3}He)^{19}F$ reaction, 25:59758
EDGAR, J. B., CCTL Mark II subassembly shipping procedure, 25:57612 (HEDL-TME-71-114)
EDLEN, Bengt, Ionization potentials of atoms and ions containing one to ten electrons, 25:58715
EDMONDS, A. R., Theory of the quadratic Zeeman effect, 25:58696
EDVALSON, Lars E., Radiolysis of citric acid solution, 25:57457 (ARH-2163)
EDWARDS, D., Time scale of expansion for cosmological models with radiation, 25:58663
EERNISSE, E. P., Permanent radiation effects in swept and unswept optical grade synthetic quartz AT resonators, 25:57906
EFANOV, V. A., Radio intensity variations of 3C 273 at 2.3 and 8.15 mm, 25:58524
EFREMOV, Yu. V., Separation of actinides and lanthanides on Zr phosphate. I, 25:57550
Separation of actinides and lanthanides on Zr phosphate. II, 25:57551
EGAWA, M., Rapid determination of boron in glass by prompt γ-ray measurement, 25:57369 (RFP-Trans-83)
EGGEN, O. J., Some red giants of the old disk population, 25:58449
EGGINGTON, M. A., Mass and spin diffusion near lambda line in dilute ^{3}He--^{4}He mixtures, 25:58926
EGIAZAROV, B. G., System for automated one-element activation analysis, 25:57390
EGIAZAROV, Boris Grigorievich, Determining the content of chemical elements or isotopes thereof in a specimen by utilizing the effect of recoilless resonance absorption or scattering of gamma rays, 25:57354
EGIYAN, K. Sh., Arrangement for direct nuclear reactions produced by electrons and gamma quanta up to 300 MeV, 25:59646
EGUCHI, Tohru, Removal of the degeneracy in the dual resonance model, 25:59457
EHAMN, Michael Frederick, Surface reactivity and basic etching mechanism studies on Ge, Al, and UO_2, 25:58244
EHRING, F., Radionecrosis of the skin, 25:58038
EHRKE, F., Processing data in nuclear medicine with the aid of desk-top computers, 25:58065
EICHHOLZ, G. G., Synergistic treatment of textile dye wastes by irradiation and oxidation, 25:57452
EICHINGER, P., Determination of carrier-mobility and lifetime in p--i--n detectors from the response to modulated light, 25:57738
EIDMAN, V. Ya., Possible antenna mechanism for cosmic radio emission, 25:58526
EINHORN, M. B., Bound on absorptive part of elastic scattering amplitudes, 25:59630
EISEN, F. H., III--V compound review, 25:59138
EL BAZ, E., Non-exhaustive restatement of the angular momentum reduction in the three-body problem, 25:59206 (LYCEN-7118)
ELEN, J. D., Some electron microscope observations on voids in V, Nb, and Mo, 25:58309
ELINSON, S. V., Photometric determination of niobium with magneson, 25:57315
ELISEEV, S. M., Statistical reconstruction of inelastic π-N and N-N interactions in the superhigh energy region, 25:59472 (JINR-P2-6022)
ELITZUR, Moshe, Feynman's relation for particle production near boundary of phase space, 25:59332
ELKIND, M. M., Damage and repair processes relative to neutron irradiation, 25:58089
ELLINGTON, H. I., Properties of a high-current discharge in alkali-metal-seeded rare gases, 25:59023
ELLIS, A. N., Method of calibration of Moxon--Rae detectors, 25:57789
ELLIS, John, Aspects of conformal symmetry and chirality, 25:59542
ELLIS, W. E., New source of helium in cladding materials, 25:58336
ELSWICK, T. C., Neutron emission rate reduction in PuO_2 by oxygen exchange, 25:57655 (MLM-1844)
ELTYSHEVA, A. A., Investigation of volatilization of MgO and ZrO_2 in oxidizing atmospheres, 25:58345
EL-WAKIL, M. M., Nuclear heat transport, 25:60222
ELYUTIN, O. P., Superconducting alloys of Nb--Al--Ge system, 25:58948
ELYUTIN, V. P., Influence of the nature of a graphite lattice on the rate of impregnation by molten zirconium, 25:58245
EL-ZEFTAWY, Medhat M., Kinetic distortion in a TRIGA reactor with an asymmetric reflector, 25:60162
EMEL'YANOV, I. Ya., Helium escape from irradiated borated materials with carbon--graphite matrix, 25:58378
EMTZEV, V. V., Donor--vacancy type complexes in germanium, 25:59133
ENAYETULLAH, M., Measurements of the total neutron cross section of praseodymium between 1 and 18 MeV, 25:59811
ENDO, Kouichi, Examination of blood counts on radiclogical technicians in Japan, 25:58134
ENDO, Yorimasa, Energy levels of ^{142}Nd, 25:59821
ENGDAHL, E. R., Explosion effects and earthquakes in the Amchitka Island region, 25:57597
ENGELS, J., Generalized potential and uniqueness in calculation of pion--nucleon P_{33} state, 25:59485
ENGLER, Hans, Role of spin--orbit scattering in high-field superconducting tunneling, 25:58939
ENGMANN, R., Lifetime measurements in sd shell nuclei. VII, 25:59751
ENKEN, V. B., Radiosensitivity of wheat, 25:58152
EPSTEIN, M. B., Effects of the neutron pickup process on $^{3}He(p,pd)p$ quasi-free scattering, 25:59702
ERDAS, F., Dispersive approach to $^{4}He(\gamma,d)d$ reaction, 25:59698
EREMINA, G. V., Mixed complex compounds of niobium with polyphenols and organic bases, 25:57316
ERICH, Ruedl, Formation of voids by quenching or deformation of metals, 25:58319
ERICKSEN, J. H., Coupling functions applicable to the underground meson telescopes, 25:58822
ERICKSON, Glen W., Improved Lamb-shift calculation for all values of Z, 25:58813
ERICKSON, Jon J., Multicrystal tomographic scanner for mapping thin cross section of radioactivity in an organ of the human body, 25:57754
ERKKILA, B. H., Determination of ^{12}Be ground-state mass, 25:59716
ERLEWINE, John T., Role of contracting in the development of atomic energy, 25:60017
ERMOLAEV, N. P., Analysis of processes of uranium redistribution and detachment from rocks during their progressive metamorphism, 25:57581
ERMOLENKO, I. N., Conditions for cerium sorption by

chromatographic paper modified with carboxylic acids for its determination by the peroxide method, 25:57331
EROFEEV, R. S., Neutron detector, 25:57728
EROKHIN, N. S., Influence of longitudinal density gradient on the transformation and emission of transverse waves from a beam-plasma discharge, 25:59104
EROSHENKO, V. M., Experimental determination of the electron concentration and temperature of an argon plasma jet by means of lasers, 25:58987
ERSHOV, A. T., Formation of braking radiation beam of medical betatron, 25:59651
ERUKHIMOV, L. M., Slow variations of pulsar radio emission, 25:58522 (CSIRO-Trans-10649)
ERVIN, Guy Jr., Preparation of tungsten-modified mixed carbide, 25:58365 (AI-AEC-12983)
ESCH, Louis James, Temperature dependence of neutron inelastic scattering from water, 25:59685
ESCHBACH, H. L., Preparation of standard layers by vacuum evaporation, 25:58182 (CONF-711002-, pp 122-33)
ESKA, G., Measurements of NMR on oriented ^{192}Ir and /sup 191m/Ir in Ni and Fe host lattices, 25:59807
ESTOURNEL, R., Exposure of human beings to natural and artificial sources of ionizing radiations, 25:57994
ETSELL, Thomas Harvey, Electrical properties of La_2O_3--CaO, Y_2O_3--CaO, and ZrO_2--CaO solid electrolytes, 25:59193
EVANS, A. G., Comparison of stainless steel and Zircaloy-2 as encapsulation materials for ^{252}Cf, 25:58242
EVANS, D., Analysis of the reaction $\pi^+p \to$ rho$^0\Delta^{++}$ at 11.7 GeV/c incident momentum. I, 25:59315
EVANS, H. J., Use of chromosome aberration frequencies for biological dosimetry in man, 25:58013
EVANS, J. H., Comparison of the damage structure in fast reactor and accelerator irradiated molybdenum, 25:58332
  Regular void array in high purity Mo, 25:58340
EVANS, T. L., Process chemistry for burner product from graphite fuels containing niobium, 25:57519 (IN-1484)
EVANS, W. F. J., Study of (4-1) and (5-2) hydroxyl bands in night airglow, 25:58902
EVRARD, D., Reaction anti pd $\to$ p/sub s/$\pi^+2\pi^-\pi^0$ at 5.5 GeV/c, 25:59276
EVSEEV, V. S., Angular distribution of the low energy neutrons from the nuclear μ-capture in sulfur and calcium, 25:59738 (JINR-P1-6029)
EVSTYUKHIN, A. I., Structural peculiarities of polycrystalline molybdenum hardening during extrusion, 25:58277
EXTERMANN, P., Measurement of K/sub e4/$^+$-decay rates and test of /S = ΔQ rule, 25:59262
EYRE, B. L., Comparison of the damage structure in fast reactor and accelerator irradiated molybdenum, 25:58332
EZAWA, Zyun F., Does duality hold in current interactions, 25:59363

F

FABBRI, F., SASSI: FORTRAN program for calculation of neutron scattering from a spherical optical potential, 25:59842 (RT/FI-(71)6)
FADDEEV, L. D., Invariant perturbation theory for nonlinear chiral Lagrangian, 25:59574
FAHLMAN, G. G., Rapidly rotating polytropes in post-Newtonian approximation to general relativity, 25:58495
  Rapidly rotating supermassive stars in approximation to general relativity, 25:58496
FAHR, H. J., Interplanetary hydrogen cone and its solar-cycle variations, 25:58578
  Interstellar matter and the location of the shock front, 25:58631
FAINBERG, V. Ya., Bounds on the elastic amplitude in nonlocalizable field theories, 25:59565
FAINBERG, Ya. B., Influence of longitudinal density gradient on the transformation and emission of transverse waves from a beam-plasma discharge, 25:59104
FAIRALL, A. P., Compact galaxies, 25:58648
FAIRFIELD, D. H., Relationship of interplanetary parameters and occurrence of magnetospheric substorms, 25:58856
FALL, S. M., Phenomenology of muon showers underground, 25:59247
FALLIEROS, S., Energy displacement of dipole isodoublets, 25:59853
FANCHIOTTI, H., Regularization of three-vertex Feynman diagrams produced by three-point supergraphs, 25:59568
FANO, U., Z dependence of spin--orbit coupling, 25:58716
FANT, B., E2 core polarization by neutrons in (i/sub 13/2/)$^{-2}$ configuration in ^{206}Pb, 25:59818
  Evidence for high-spin core-excited states in ^{210}Po, 25:59817
FARAGGI, M., Effect of thallous ions on the yields of hydrogen and hydrogen peroxide in radiolyzed aqueous solutions, 25:57472
FARAGGIANA, R., Activity phase of CH Cygni during 1967 to 1970, 25:58482
FARKAS, A., Proton magnetic resonance study on light- and heavy-water solutions of Be(II), 25:57429
FARMER, F. R., Review of fast reactor safety, 25:60113 (CONF-710922-3)
  Safety aspects of fast reactors, 25:60136
FARMERY, B. W., Low-angle scattering of energetic ions from an amorphous surface, 25:58689
FARRELL, J. A., Method of calibration of Moxon--Rae detectors, 25:57769
FARRELL, K., Effects of structural imperfections on voids in aluminum, 25:58298 (ORNL-TM-3493)
FARUKHI, M. R., Barium fluoride as a gamma ray and charged particle detector, 25:57817
FASTRUP, B., Probability for producing K vacancies in violent ion--atom collisions at keV energies, 25:58756
FAUGHT, M. L., Systems approach to nuclear plant protective systems data program, 25:60208
FAUST, J., Proportional wire chamber electronics system utilizing CAMAC, 25:59656
FAVA, L., Reactor physics heterogeneous methods developed at CISE. I, 25:60040
FAYARD, C., Non-exhaustive restatement of the angular momentum reduction in the three-body problem, 25:59206 (LYCEN-7118)
FAYET, P., Galilean invariance in the infinite momentum frame and the parton model, 25:59431
FAYNOT, J. M., Upward-moving irregularities in the subequatorial ionosphere, 25:58877
FAZYLOV, U. T., Mutagenic effects of different types of radiation on germ cells of male mice. VI, 25:57967
FAZZINI, T., Spin and parity of some excited states of ^{48}Sc, 25:59756
FEDER, H. M., Prog. rpt. on physical chemistry of liquid metals and molten salts, semiannual, 1--6/71, 25:58387 (ANL-7823)
FEDERBUSH, Paul, Convergent expansion for resolvent of phi^4/sub 1 + 1/, 25:59581
FEDORCHENKO, A. M., Surface waves in a magnetized plasma, 25:59092
FEDORENKO, N. V., Electron capture and loss for hydrogen atoms, protons, and negative ions in gases, 25:58742
FEDOROV, N. F., Nature of anomalies in resistive state of a superconductor, 25:58937
FEDOROV, V. I., Wave absorption in a magnetoactive plasma with small transverse dimensions, 25:59088
FEDOROVA, N. D., Determination of cerium in refractory alloys with use of chromatographic separation, 25:57338
FEDOTOV, S. I., Investigation of the laser initiated discharge spark channel, 25:59076 (UCRL-Trans-10556)
FEDROROV, G. A., Comparison and analysis of the parameters of clinical whole-body spectrometers, 25:57823
FEDYAKOV, V. P., Fine structure of the distribution function of ions in the plasma of a strong-current z discharge, 25:59024
FEHER, L., Operative statutes of radiation protection, 25:58027
FEHRENTZ, D., Influence of body inhomogeneities on dose distribution during electron and roentgen irradiation with 42 MeV betatron, 25:58141
FEIGT, I., Spectral noise intensity of silicon detectors, 25:57742
FEINE, U., Evaluation of photo-scintigrams by means of television reproduction and subtraction, 25:58059
  Processing data in nuclear medicine with the aid of desk-top computers, 25:58065
FEL, N. S., Pulse-radiolysis studies of some nucleic acid fragments in aqueous solutions, 25:57930
FELICETTI, F., High-energy electron--positron elastic scattering, 25:59250
  Mulitparticle production from e^+e^- interactions as high energy, 25:59251
FELLGETT, P. B., Gravitational wave astronomy: an interim survey, 25:59607
FELTGEN, R., Total effective cross sections for scattering of He, HD, and D_2 by several molecules, 25:58782
  Total effective scattering cross sections of HD-inert gas systems in thermal energy region, 25:58781
FENEUILLE, S., Application of the factorization method and group theory to the relativistic treatment of hydrogenic radial functions, 25:58821
  Study of (d + x)/sup n/p/sup m/ configurations using the SU_3 group, 25:58787
FERGUSON, A. J., Charge-exchange and/or knockout spectator poles in reaction D(^{3}He,tp)p, 25:59694
FERNANDES, N. C., Luminosity of high-temperature stars, 25:58433
FERREIRA, J. G., Fluorescence, Auger, and Coster--Kronig L/sub II/ subshell yields of Th, 25:58719
FERU, J., Saint-Laurent I fuel melt down incident, 17 Oct 1969, 25:59924
FESSENDEN, P., New measurements of (π^+,2p) reactions on light nuclei, 25:59709 (LA-DC-12389)
FETTER, Alexander L., Core structure of a quantized vortex, 25:58923
FICHET, M., Linear conversion of waves for an oblique incidence, 25:59082 (CEA-CONF-1803)
FIDECARO, G., Comparison of high-energy hadron--deuteron scattering data with Glauber model, 25:59269
FIDLER, R. S., Classification of the indium--zinc eutectic, 25:58286
FIDONE, I., Coupled equations in the theory of linear wave conversion, 25:59105
  Linear conversion of waves for an oblique incidence, 25:59082 (CEA-CONF-1803)
  Nonlinear harmonic generation in a thermal magnetized

plasma, 25:59013 (CEA-CONF-1835)
FIEDLER, H. J., Contamination of soils and plants with ^{90}Sr as consequence of nuclear weapons tests during period 1960--1963, 25:57986
FIELD, R. D. Jr., Evidence on duality and exchange degeneracy from finite-energy sum rules, 25:59501
FIGUET, Maurice G., Apparatus for determining the density of pulveralent materials in reservoir by means of a radioactive source and detector, 25:57872
FILIP, R., Development of pressure vessel steels for Czechoslovak Nuclear Stations, 25:58216 (ZJE-106)
  Properties of zirconium alloys from the operation standpoint, 25:58217 (ZJE-107)
FILIPPOV, A. P., Oxidation and dissolution of U compounds in nonaquecus media. I, 25:57547
  Oxidation and dissolution of U compounds in nonaqueous media. II, 25:57548
FILIPPOV, A. T., Approximate methods for solving Schroedinger equation with marginally singular potential, 25:59205 (JINR-E2-6043)
FILIPPOV, B. F., Modification of cast zirconium by additions of transition metals, 25:58258
FILIPPOV, E. S., Structural transformations in cobalt--vanadium melts, 25:58281
FILIPPOVA, N. V., VVR reactor semiautomatic activation analysis system, 25:60168
FINJORD, J., Elastic and single-charge-exchange scattering of pions by carbon nuclei, 25:59523
FINKEL'SHTEIN, E. I., Low-temperature radiation polymerization of acrolein in the solid state. I, 25:57531
FINKELSTEIN, J., Selection rules for Regge cuts, 25:59440
FINNEGAN, Patrick M., Preliminary impact speed and angle criteria for design of a nuclear airplane fission product containment vessel, 25:60192 (N-71-25411)
FINZI, U., Accessibility of exact nonlinear stationary states in water-bag model computer experiments, 25:59025 (CEA-CONF-1832)
FIORE, L., Photofission of ^{232}Th near threshold, 25:59786
FIORENTINI, P., Nuclear energy in Europe, 25:59901
FIORINI, E., Background measurement of a Ge(Li) detector, 25:57803
FIREBAUGH, M. W., Observation of natural-parity exchange in rho^0 production, 25:59286
FIRESTONE, F. R., Prog. rpt. on kinetics of ionizing-radiation induced reactions in organic compounds, annual, 12/70--11/71, 25:57458 (COO-1116-17)
FISCHER, Erich, Use of radionuclides in food science and technology, 25:57913
FISET, E. O., Finite-difference solution of axially symmetric nuclear single-particle potentials, 25:59839 (LA-4735)
FISHER, A., Program for the determination of neutron spectra from activation data, 25:57725 (KFKI-71-22)
FISHER, Richard R., Abundance of calcium in the solar corona, 25:58605
  Distribution of material as function of temperature in post-flare loop system, 25:58607
  Monochromatic observations of a coronal loop, 25:58606
FISHER, S. B., Theoretical model for void formation in the high voltage microscope, 25:58316
FISHER, T. R., Elastic scattering of 5- to 10-MeV protons from aligned ^{165}Ho, 25:59788
FITE, W. L., Lyman-alpha emission induced by the collisions of electrons with molecular hydrogen, 25:58729
FLACH, G., Development of nuclear power technical school, 25:59916
FLEISHMAN, D. G., Cosmogenic ^{22}Na in surface waters of dry land, 25:57568
FLETCHER, E. R., Effects of airblast on sheep in two-man foxholes, 25:60272 (DASA-2711)
FLINCHUM, Joann H., Processing codes for group-averaged discrete ordinates cross-section tables, 25:59843 (SC-DR-710320)
FLOWERS, B. H., Nuclear models, 25:59849
FLUSS, M. J., Chemical Engineering Division. Cross sections and burnup semiannual report, January--June 1971, 25:60035 (ANL-7824)
FOGEL, Ya. M., Diffusion of substrate atoms into a surface film as indicated by the secondary ion--ion emission characteristics, 25:58266
FOGELBERG, B. C., Application of neutron activation analysis for the determination of trace amounts of bromine in pulp, 25:57383
FOKINA, L. S., Determination of cerium in refractory alloys with use of chromatographic separation, 25:57338
FOKKER, A. D., Faraday rotation dispersion and distribution of polarization characteristics of Type III bursts, 25:58610
FOLEY, R. S., Ball bearing design for SNAP-8 turboalternator and mercury pump, 25:57617 (N-71-26910)
FOLOMESHKIN, V. N., Quadratic Lagrangians in general relativity, 25:59603
FOLSOM, T. R., 1971 results for intercomparison of analytical methods for ^{137}Cs and ^{134}Cs used at Scripps with methods used at 56 other institutions, 25:57348 (TID-25777)
  Natural cesium in sea water, 25:57301 (TID-25776)
FOMENKO, V. S., Electron deceleration by dislocations in Type-II superconductors, 25:58932
FOMICHEV, V. A., X-ray spectra and energy band schemes of BeO and BN, 25:59178
FOMIN, A. V., New radiometric apparatus for prospecting radioactive ores, 25:57867
FOMIN, V. V., Rate of extraction in systems with tributyl phosphate, 25:57557
FONTAN, J., Pollution of the atmosphere in uranium mines, 25:57564
FORCINAL, G., Recent developments of well-type detectors with less than 5 microns dead-layer, 25:57799
FORD, Leonard, Analysis of radiopharmaceuticals, 25:57350
FOREMAN, A. J. E., Temperature range and dose dependence for void growth in irradiated materials, 25:58314
FOREST, J. D., Advanced composite materials in spacecraft, 25:58422
FORMAN, R. E., Interaction of gas atom with a hot solid surface, 25:58690
FORREST, J. R., Low-frequency waves and instabilities in a magnetoplasma, 25:59072
FORSTER, George A., Performance of permanent magnet flow-through-type sodium flowmeters in EBR-II instrumented subassemblies, 25:60182
FORSTER, J. S., Charge-exchange and/or knockout spectator poles in reaction D(^{3}He,tp)p, 25:59694
FORTESCUE, Peter, Tomorrow's plant: gas turbines, nuclear power, dry cooling, 25:60140
FORTUNE, H. T., Evidence for quartet states in ^{20}Ne, 25:59717
FOSTER, C. C., High-resolution 5000μ silicon surface-barrier detectors, 25:57801
FOSTER, J. C., Relationship of interplanetary parameters and occurrence of magnetospheric substorms, 25:58856
FOTEEV, N. K., Electric-erosion machining of deep cylindrical apertures, 25:58193
FOWLER, I. L., Some observations on germanium γ-ray spectrometers made from high purity p-type material, 25:57820
FOWLER, K. A., Nuclear reactor applications of new ultrasonic transducers, 25:57898
FOWLER, R. D., New high-temperature phase of protactinium metal, 25:58291
FOX, Donald Lee, Quantum mechanical calculations of empirical potentials by perturbation method and oxygen diffusivity in polycrystalline Pr_7O_{12}, 25:58372
FOX, Jay A., Evaporation of charged particles from excited Ag and Br nuclei, 25:59822
FOX, Margaret, Influence of recovery from sublethal damage on the response of cells to protracted irradiation at low dose-rate, 25:58088
FRAENKEL, Zeev, Variance of number of neutrons emitted in fission of ^{252}Cf, 25:59824
FRAMPTON, P. H., Relative importance of dual loops, 25:59445
FRANCIS, J. E., Proposal for computer assisted data acquisition for ORNL fusion experiments, 25:59075 (ORNL-TM-3593)
FRANCOIS, B., Counting tritiated water, 25:57363
FRANK, V., Generalized potential and uniqueness in calculation of pion--nucleon P_{33} state, 25:59485
FRANK, W., Static crowdions in electron-irradiated Au-15 at. percent Ag alloys, 25:59153
FRANKFURT, L. L., Electromagnetic corrections to high-energy electron--hadron scattering, 25:59372
FRANK-KAMENETSKII, D. A., Plasma heating at the electron cyclotron frequency, 25:58971
FRANKLIN, R. N., Interaction between ion--acoustic waves and ionization waves, 25:59098
  Nonlinear interaction of electron plasma waves, 25:59099
FRANZ, K.-D., Influence of body inhomogeneities on dose distribution during electron and roentgen irradiation with 42 MeV betatron, 25:58141
FRASER, H. L., Voids in intermetallic compound NiAl, 25:58318
FRASER, John K., Evaluation of methods to recover plutonium from incinerator ash, 25:57525 (RFP-1723)
FRAUTSCHI, S., Ultradense matter, 25:58432
FRAZER, Jack W., Modes of computer automation in the chemistry laboratory, 25:60293 (UCRL-72001)
FRAZIER, John Melvin, Application of elementary particle techniques to problems in nuclear weak interactions, 25:59397
FRED, M., Why the Hartree--Fock F/sup k/ integrals are too large, 25:58797
FREEDMAN, A. Y., Standard reference materials: standard samples issued in the USSR, 25:57297 (NBS-SPEC. PUBL.-260-30)
FREEDMAN, D. Z., Sum rules for inclusive cross sections, 25:59331
FREEMAN, J. H., Chemical effects of nuclear transformations in alkali chlorides. III, 25:57503
FREIDBERG, J. P., High-frequency electrostatic plasma instabilities, 25:59067
FRENCH, P. M., Examination of the microstructures of mixed uranium--plutonium dioxide fuel pellets for fast flux irradiation studies, 25:58397
FRETWURST, E., Current pulse shapes of semiconductor detectors, measured with an averaging technique, 25:57737
FREUND, Robert S., Dissociation of CO_2 by electron impact, 25:58765
FRIAR, J. L., Simple relations among multiple scattering amplitudes in light nuclei, 25:59524

XUM

FRIDMAN, A., Reaction anti pd $\to$ p/sub s/$\pi^+2\pi^-\pi^0$ at 5.5 GeV/c, 25:59276
FRIDMAN, A. M., Stability of globular clusters and spherical galaxies, 25:58430
FRIDRICH, R., Irradiation hazard in medicine, 25:58139
FRIED, A. R. Jr., Structure and conformation of Th(IV) complexes of diethylenetriaminepentaacetic acid in aqueous solution, 25:57436
FRIEDENSTEIN, Alexander, Osteogenic precursor cells of bone marrow in radiation chimeras, 25:58121
FRIEDJUNG, M., Balmer absorption lines of Nova Herculis 1963, 25:58436
FRIEDMAN, Jerome H., Efficient Monte Carlo event generation method for multiperipheral models, 25:59213
FRIEDRICH, Hans, Cross sections for single-quantum annihilation of low-energy positrons in iodine, 25:58723
FRIEDRICH, O. M., Plasma diagnostics utilising optical interferometry and holographic techniques, 25:59001
FRISCH, Erling, Nuclear reactor control device, 25:60244
FRISHKORN, G. W., Evaluation of ion-exchange surveillance sampler for analyzing radioactive liquid effluents, 25:57351
FROHOFER, H., Microanalytical determination of carbon and hydrogen, ^{14}C, tritium and deuterium in stream of nitrogen, 25:57349
FROLOV, A. S., Properties of ceramic coatings of phosphate ceramics, 25:58375
FROLOV, S. G., Dosimetric characteristics of silicon detectors for gamma radiation, 25:57850
FROLOV, V. V., Ionization chambers with a liquid dielectric, 25:57778
  Study of a tissue-equivalent spherical proportional counter, 25:57853
FROMM, E., Nitrogen solubility in metals of high melting points, 25:58249
FROMMER, P. L., Experimental evaluation of a radioisotope-powered cardiac pacemaker, 25:57669
FRY, D. N., Investigation of boiling detection in the HFIR using out-of-core instrumentation, 25:60181
FRYER, R. M., Experimental irradiations of fuel elements having known cladding defects in EBR-II, 25:60082 (ANL-7782)
FUBINI, S., Recent progress in current algebra, 25:59323
FUCHS, W. A., Angiography, scintillation scanning, and ultrasound tomography of liver, 25:58044
FUENZALIDA, S., ^{111}In: new radioisotope for cysternoscintillography, 25:58052
FUJII, Takenori, Design of safety valves and the like for BWR-type power stations, 25:57637
FUJITA, Hyota, Performance of clinical linear accelerator, 25:59661
FUJITA, Shigeji, Resolution of the hierarchy of Green's functions for fermions, 25:59218
FUKETA, T., ^{208}Pb(γ,n)^{207}Pb reaction near threshold, 25:59778 (JAERI-Memo-4520)
FUKUDA, R., Violation of Pomeranchuk-theorem conditions and odd-signature amplitude, 25:59329
FUKUGITA, M., Dual structure of anti KN scattering in intermediate energy region, 25:59504
FUKUSHIMA, Susumu, Three phase region in system UO_2--PuO_2--Pu_2O_3, 25:58409
FUKUTOME, Hideo, Unrestricted Hartree--Fock equation and its solutions. I, 25:59239
FULCHER, Lewis P., Superheavy elements and an upper limit to the electric field strength, 25:59554
FULDE, Peter, Role of spin--orbit scattering in high-field superconducting tunneling, 25:58939
FULLWOOD, R. R., Method of calibration of Moxon--Rae detectors, 25:57789
FULTON, E. J., Density changes in cladding materials irradiated in DFR, 25:58306
  Electron microscope observations of voids in cladding materials irradiated in DFR, 25:58307
FUNAHASHI, Akimasa, High density theta-pinch plasma pre-ionized by shock wave, 25:59056
  Microwave interferometric measurements in medium-beta torus (JFT-2), 25:58979 (JAERI-Memo-4530)
FUNG, P. C. W., Longitude distribution of solar flares, 25:58570 (N-71-14166)
FUNG, S. Y., π^+p elastic scattering data between 1820- and 2090-MeV cm energy, 25:59309
FURR, A. Keith, Neutron activation studies of the Roanoke River system, 25:57395
FURUKAWA, M., Production of ^{26}Al and ^{22}Na, 25:59753
FURUSE, Takeshi, Electron microscopic study of radiation effects on cultured cells with different radiosensitivities, 25:58085
FURUTANI, Y., Test-particle propagator of Lenard--Bernstein equation for magnetoplasma, 25:59087
FUTEKOV, L., Rapid photometric determination of selenium in tellurium with different purity (up to 99.99 percent), 25:57323
FYKIN, L. E., Direct observation of fluctuations of deuterium distribution in $(Nb_{0\ 33}Ti_{0\ 66})D_{0\ 33}$, 25:58278

G

GABAI, A., ^{153}Eu indirect spin--spin interaction, 25:59200
GABATHULER, E., Real part of the rho--nucleon forward scattering amplitude and the relative rho--ω production phase, 25:59252
GABE, D. R., Study of the electrochemistry and morphology of electro-deposited nickel--molybdenum alloys, 25:58256
GABOS, Zoltan, Mass of muon neutrinos, 25:59257
GABRAKOV, S. I., 0^+ and 1^+ unlike particle-hole states in deformed odd--odd nuclei and β-strength functions, 25:59872
  Elastic scattering of high-energy protons on nuclei, 25:59509
GABRIEL, A. H., Ultraviolet solar spectrum during total eclipse of Mar. 7, 1970, 25:58617
GABRIEL, T. A., Calculation of the nucleon- and pion-induced star and flux distributions from 400-GeV proton interactions in iron, 25:59507 (ORNL-4673)
GACHON, Herve, Deformation and ultimate strength of a concrete under triaxial stress, 25:58415 (FRNC-TH-61)
GACS, F., Operative statutes of radiation protection, 25:58027
GADEKEN, L. L., Production of three ^{4}He nuclei by direct interaction of ^{6}Li with ^{6}Li, 25:59718
GAGELIN, J. J., Multiple proportional gas counter for the cartography of radioelements, 25:57774
GAIDE, Albert, Stellar ultraviolet and UV stars, 25:58445
GAILLARD, M., Polarization of H/sub β/ line emitted in $Li^+ + H_2$ collisions, 25:58780
GAINAR, I., Transfer annealing in Cr(III) trisacetylacetone, 25:57496
GAKH, G. I., Production of neutral pseudoscalar mesons in reactions $e^+ + e^- \to \pi^0(\eta^0 X^0) + \gamma$, 25:59377
GALIMOV, D. G., Structure of irradiated tellurite glasses, 25:57447
GALKIN, V. Ya., Determination of photonuclear reaction cross sections, 25:59772
GALKINA, L. L., Determination of Eu, Tb, Sm, and Dy in optical fluorite, 25:57332
GALLANT, J. L., Special techniques in target preparation, 25:59639 (CONF-711002-, pp 134-43)
GAMMAGE, R. B., New exoelectron dosimeters, 25:57835
GAMMEL, John L., Formalism for the [polarized] T(d,n)^{4}He and ^{3}He(d,p)^{4}He reactions, 25:59837 (LA-4492)
GAMOTA, G., Ions and vortices in ^{4}He, 25:58917
GANGADHARA RAO, Y. V. B., Immunity developed in chickens using irradiated eggs, 25:57946
GANIEL, U., Equation of motion for P representation, 25:59208
GANOPOL'SKII, V. I., Conditions for cerium sorption by chromatographic paper modified with carboxylic acids for its determination by the peroxide method, 25:57331
GARBAUSKAS, G. K., Determination of cobalt in nickel preparations by a radiochemical method, 25:57356
GARCIA, J. C. R., Thermodynamic behavior of the ''multiflash'' evaporator, 25:57616 (LFEN-NI.-54-a)
GARCIA CANAL, C. A., Regularization of three-vertex Feynman diagrams produced by three-point supergraphs, 25:59568
GARDNER, N., Evidence for negative parity rotational bands in ^{24}Mg, 25:59767
GARI, M., Interaction current contributions to parity non-conserving nuclear γ-transitions, 25:59856
GARIN, A., Charged particle detectors made by implantation, 25:57749
GARLICK, G. F. J., ESR studies of intrinsic and impurity defects in silica and germania, 25:59174
GARRETT, J. D., Evidence for quartet states in ^{20}Ne, 25:59717
GARRETT, Roger E., Device and method using gamma rays for size and density produce selection, 25:57871
GARSEVANISHVILI, V. R., Quasipotential formalism for the two-particle system with spins 0 and $^1/_2$, 25:59422 (JINR-E2-6046)
  Quasipotential theory of high-energy hadron scattering, 25:59442
GARSTANG, R. H., Relativistic radiative transitions, 25:58816
GARTON, W. R. S., Ultraviolet solar spectrum during total eclipse of Mar. 7, 1970, 25:58617
GARVEY, G. T., High-resolution 5000μ silicon surface-barrier detectors, 25:57801
GASPAR, Peter Paul, Prog. rpt. on reaction studies of hot silicon and germanium radicals, annual, 9/70--8/71, 25:57487 (COO-1713-25)
GASPARINI, Francis Marino, Heat capacity of liquid ^{4}He and ^{3}He--^{4}He mixtures at lambda transition, 25:58919
GAST, K., Propagation of local disturbances in the care of fast sodium-cooled reactor and their significance for reactor safety, 25:60117 (KFK-1380)
GATLEY, John Andrew, Improvements in or relating to nuclear reactor fuel elements, 25:60250
GAUR, V. P., Dependence of molecular dissociation equilibrium on magnetic field strength in sunspots, 25:58589
  Dissociation equilibrium of some diatomic molecules in delta Cephei, 25:58479
GAVIN, A. P., High-temperature acoustic sensors for boiling detection, 25:60090
GAVRILOV, V. E., Plasma temperature determinations near a

XUM

dielectric surface, 25:58985
GAVRILOVIC, Milan, Graphic determination of the parameters of the temperature field in the concrete of the reactor biological shield, 25:60056
GAVRON, Avigdor, Variance of number of neutrons emitted in fission of ^{252}Cf, 25:59824
GAVRYUSHENKO, B. S., Determination of parameters of nonequilibrium plasma in a restricted volume allowing for step-wise ionization, 25:59034
GAWLOWSKI, J., Gamma radiolysis of gaseous ethylene in the presence of isobutylene, 25:57474
GAZIEVA, M. T., Elimination of the effect of the sample composition on the line intensity of certain rare metal impurities, 25:57330
GEBHARDT, D. O., Cleft palate or oligodactylia in mouse embryo induced by x rays or cyclophosphamide, 25:58127
GEFTER, V. M., Expansion in vacuum of rarefied plasma with ions of two types, 25:59049
GEICZY, I. I., Luminescence of irradiated β-SiC, 25:59139
GEISLER, S., Calculation, construction, and testing of collimators used for scintigraphy with low-energy radionuclides, 25:57891
GELBART, William Martin, Cytogenetics of zeste expression in Drosophila melanogaster, 25:57975
GELL, Yakov, Evaluation of low-energy ΣN interaction parameters, 25:59525
GEL'MAN, A. D., Heptavalent state of neptunium and plutonium, 25:57404
  Heptavalent state of transuranium elements. XII, 25:57412
GEMMELL, Donald S., Angular distributions for T/sub np/ = 1 and T/sub np/ = 0 transfers in (^{3}He,p) reactions, 25:59741
GENKIN, Ya. E., Temperature dependences of Debye--Waller factors of Zr, Nb, and Mo, 25:59179
GEORGE, Jacqueline, Conjugal transfer of uv-damaged F-prime sex factors, 25:57956
GEORGHIOU, G. P., Histopathological studies on irradiated and chemosterilized beet leafhoppers, Circulifer tenellus, 25:58093
GERARDO, J. B., Electronic recombination coefficient of molecular helium ions, 25:58714
GERASIMENKO, V. P., Measurement of radiation heat release value in structural and moderating materials of reactor IVV-2, 25:60022
GERBER, G. B., Biochemical indicators of radiation injury, 25:58126
GERISCH, G., Problem of locating nuclear power plants, 25:60119
GERJUOY, E., Glauber amplitudes in charged-particle--hydrogen-atom collisions, 25:58766
GERONIMI, Christian, Connection and quantum field theory in a curved space--time, 25:59578
GERSTEIN, B. C., Low-temperature magnetic behavior of several oxides of gadolinium, 25:59198
GETMAN, I. A., Effect of synthesis temperature on the sintering of boron nitride, 25:58358
GETSELEV, I. V., Radiation safety of crew of Soyuz-9, 25:58006
GEY, A., Detection and alarm system for accidental nuclear excursions, 25:57780
GHEORGHE, D., Program for the computing of the scattering cross-sections in heavy water, 25:59671 (IFA-DNBR-3)
  Riva--Butler's code, 25:59689
GHERSETTI, Sergio, Energy levels and molecular constants of $^{12}C_2H_2$, $^{12}C_2D_2$, and $^{12}C_2HD$, 25:57433
GHERSINI, G., Spectrophotometric determination of Cd in nuclear-grade Zircaloy-2 after selective extraction with liquid anion-exchanger, 25:57326
GHORAI, S. K., Some (n,p) cross-sections of ^{46}Ti, ^{47}Ti, and ^{48}Ti, 25:59755
GHOSH, A. K., Probe geometry effects on turbulent plasma diagnostics, 25:58983
GIANNATIEMPO, A., Spin and parity of some excited states of ^{48}Sc, 25:59756
GIBALO, I. M., Group concentration of elements by extraction with a hydroxyquinoline melt, 25:57312
  Mixed complex compounds of niobium with polyphenols and organic bases, 25:57316
GIBSON, Everett K. Jr., Distribution of total nitrogen in iron meteorites, 25:58423
GIBSON, J. A. B., Surface dosimetry using thermoluminescent discs, 25:57837
GIBSON, T. O., Dividing head tabulations, 25:60273 (LA-4421)
GIERLIK, E., Measurement of γ-ray spectra accompanying radiative capture of nucleons, 25:59801
GIFFON, M., Reconstruction of amplitudes for pion--nucleon scattering from experimental data, 25:59498
GIJBELS, R., Instrumental neutron activation analysis of rocks with a low-energy photon detector, 25:57387
GIL, F. B., Fluorescence, Auger, and Coster--Kronig L/sub II/ subshell yields of Th, 25:58719
GILCHRIST, J. le G., Resistive behavior of the superconducting surface sheath of alloys, 25:58946
GILLES, L., Transient species in the pulse radiolysis of periodate ion in neutral aqueous solutions, 25:57466
GILLETT, F. C., Photometric measurements at lambda = 11 μm of NGC 4151, 25:58654
  Search for interstellar silicate absorption in spectrum of VI Cyg No. 12, 25:58512
GILLIS, H. A., Optical measurements on solvated electrons in pulse-irradiated liquid propane, 25:57468
GINAVEN, R. O., Application of photoinduced reactions to nuclear materials safeguards problems. Project summary report, July 1, 1970--June 30, 1971, 25:57704 (GULF-RT-A-10826)
GINNS, I. S., Initial fate of hydrogen atoms and hydroxyl radicals in the radiolysis of frozen aqueous solutions of alkali halides, 25:57467
GINZBURG, V. L., High-temperature superconductivity, 25:58934
GIOVANNINI, A., Multiparticle production model with charge conservation, 25:59512
GIRNIUS, R. J., Lyman-alpha emission induced by the collisions of electrons with molecular hydrogen, 25:58729
GIROTTI, H., Regularization of three-vertex Feynman diagrams produced by three-point supergraphs, 25:59568
GIUFFRE, S., Parameter study for a Transit Time Magnetic Pumping experiment in a torus, 25:58959 (CEA-CONF-1830)
GLADKAYA, N. V., Comparison of two methods for testing the abrasive resistance of refractories, 25:58386
GLASER, F. H., Direct measurement of dose rate in the bladder and rectum using the gammameter, 25:58010
GLASOW, P., Small rod-shaped silicon detectors for medical applications, 25:57808
GLASPEY, John W., Am stars as possible members of two subgroups of Scorpius--Centaurus association, 25:58502
GLASS, Eugene D., Gas production by nuclear stimulation, 25:57605
GLASS, H. L., Application of the x-ray synergy method to analysis of room temperature compression of beryllium crystals, 25:58263
GLASSER, Marvin E., Prog. rpt. on radioactive fallout and disturbances in mid-latitude westerlies, 7/71, 25:57572 (COO-1340-24)
GLEESON, L. J., Direct observation of cosmic-ray energy losses, 25:58590
GLENN, H. D., Analysis of Jorum containment, 25:57607
GLENN, J. L., Relations among radionuclide content and physical, chemical, and mineral characteristics of Columbia River sediments, 25:57561 (TID-25786)
GLEYVOD, R., T(d Vector,n)^{4}He reaction with polarized deuterons at energies above 107-keV resonance, 25:59705
GLIKMAN, L. G., Wideroee condition and energy of particle in magnetic field, 25:59212
GLIOZZI, F., Zeros of dual resonant amplitudes, 25:59625
GLOVER, K. M., Preparation of stable and active nuclide targets, 25:59635 (CONF-711002-, pp 91-100)
GLUECK, M., rho-exchange contribution to $\gamma n \to$ rho^{-}p, 25:59385
GNAM, E., Nuclear power operated de-salination of sea water under nominal and partial load conditions, 25:60201
GNEDIN, Yu. N., Cosmic electron acceleration and the spectrum of metagalactic x rays, 25:58830
GOAD, Robert C., Join exotic materials in seconds with continuous seam diffusion bonding, 25:58201
GOBIN, P. F., Anelastic properties of irradiated aluminum cold-worked at low temperature, 25:58338
GOBLE, Robert L., Current algebra and analyticity, 25:59469
GODDARD, P., One-loop amplitudes in model of Neveu and Schwarz, 25:59433
GODED, F., Thermal neutrons. Distribution of lifetimes, 25:59686
GODOVIKOV, S. K., New Moessbauer ^{57}Co sources, 25:59203
GOEBEL, G., Application of unitarized Veneziano model to reaction $K^{+}n \to K^{+}\pi^{-}p$ at 3 GeV/c, 25:59478
GOEDBLOED, J. P., Kinks and tearing modes in simple configurations, 25:59068
GOEDE, A., Production of a very quiescent plasma in skipping magnetic fields, 25:59055
GOETZ, Allan Charles, Self-interaction and electromagnetic radiation, 25:59221
GOGOKHIYA, V. S., Approximate methods for solving Schroedinger equation with marginally singular potential, 25:59205 (JINR-E2-6043)
GOINEAU, A., Radiation induced ionic polymerization, 25:57450 (ORO-3667-1)
GOKHALE, B. G., Correlation of screening constants for K level for atoms of different Z, 25:58817
GOKSOY, K., Variations in the relationships between total ^{59}Fe uptake and heme and nonheme fractions of spleen and bone marrow in irradiated mice and mouse radiation chimeras, 25:58119
GOLAND, A. N., Transition radiation and optical properties of evaporated carbon foil, 25:58686
GOLANT, V. E., Microwave absorption by a plasma at the upper hybrid frequency, 25:59091
GOLD, V., Deuterium solvent isotope effects in methanol solution. I, 25:57427
GOLDANIGA, G., Reactor physics heterogeneous methods developed at CISE. I, 25:60040
GOL'DANSKII, V. I., Some problems of nuclear chemistry, 25:57442
  Two-proton and two-neutron radioactive decay from many-particle isomeric states of nuclei, 25:59740
GOLDBERG, L., Ultraviolet solar spectrum during total eclipse of Mar. 7, 1970, 25:58617
GOL'DFARB, V. M., Plasma parameters and the population of

XUM

excited atomic states in a low-current helium arc, 25:59017
GOLDHABER, G., Proposed method for a search for C violation via rho^0 interference in ω decay, 25:59552
GOL'DSHTEIN, D. S., Automatic ultrasonic installation for decontamination of footwear on human legs, 25:57629
GOLDSTEIN, N. P., Incore detector for measuring power and breeeding distributions in power breeders, 25:60050
GOLENETSKII, S. V., Cosmic gamma-ray measurements in range 0.3 to 3.7 MeV, 25:58831
  Investigation of γ radiation by Cosmos-135, 25:58835
  Investigation of variations of annihilation γ radiation by Cosmos-135, 25:58836
GOLOSKOKOV, S. V., Quasipotential formalism for the two-particle system with spins 0 and $^1/_2$, 25:59422 (JINR-E2-6046)
GOLOVINSKII, L. P., Thermal diffusion of traces of thallium in various molten metals, 25:58267
GOLSON, James Philip, K^-p charge exchange and elastic scattering near 1670 MeV, 25:59281
GOLUBEV, O. L., Initial phases in condensation of Zr on W, 25:58229
GOL'ZBERG, K. L., Competitive capacity of Drosophila individuals heterozygous for x-ray induced mutations, 25:57966
GOMAA, M. A., Neutron dose estimation using a natural uranium fission fragment track personnel dosimeter, 25:57854
GONED, A., Coupling between primary and secondary cosmic-ray muon variations at high energies, 25:58827
GONZALEZ, J. L., Incore detector for measuring power and breeeding distributions in power breeders, 25:60050
GOOD, Robert A., New immunoglobulin-like molecules in the serum of bursectomized-irradiated chickens (heavy(μ)chain/immunoelectrophoresis/agammaglobulinemia), 25:57934
GOODMAN, C. D., System for multiparameter pulse height analysis with repeated use of a single, fast ADC, 25:59668
  Use of arrays smaller than implied by the range of descriptors for multiparameter pulse height analysis, 25:59667
GOODWIN, Jane, Energy response of some commercial beta/gamma and neutron survey instruments, 25:57781
GOPALA RAO, G., Titrimetric determination of Fe(II), Mo(V), and Tl(I), 25:57309
GORBATOV, E. Ya., Low-temperature radiation polymerization of acrolein in the solid state. I, 25:57531
GORDEEV, E. P., Some cooling processes for the interstellar medium, 25:58623
GORDEEV, V. V., Bremsstrahlung yield as function of target thickness and atomic number in electron energy range 12 to 22 MeV, 25:59106
GORDEEV, Yu. S., Interpretation of the energy spectrum of electrons produced in atomic collisions, 25:58733
GORDON, E. M., Dual-resonance model with unequal intercepts, 25:59441
GORDON, M. A., Excitation temperatures of 18-cm OH transitions in absorbing cloud, 25:58560
GORDON, Milton P., Characterization and fractionation of tobacco leaf transfer RNA, 25:60284 (RLO-2225-T-15-7)
GORDY, Walter, Rotational spectra of NH_3 and ND_3 in the 0.5-mm wavelength region, 25:57424
GORENBURG, L. S., X-ray sensitivity of semiconductor radiation detectors, 25:57766
GORENKO, A. F., Gamma-activation method for determining carbon and oxygen in beryllium, 25:57385
GORIN, Yu. P., Experimental comparison of anti dp and anti pd total cross sections, 25:59275
GORNYI, D. S., Anisotropy of self-diffusion of yttrium, 25:58240
GORODETSKII, D. A., Adsorption of C on boundaries (100) of W, 25:58226
GORODINSKII, D. S., Automatic ultrasonic installation for decontamination of footwear on human legs, 25:57629
GOROZHANINA, R. S., Standard reference materials: standard samples issued in the USSR, 25:57297 (NBS-SPEC. PUBL.-260-30)
GORSKII, V. B., Mixed three-dimensional flows of gas in longitudinal magnetic fields, 25:59047
GORZNY, K., Effect of additives on radiochemical polymerization of styrene, 25:57454
GOSHCHITSKII, B. N., Measurement of radiation heat release value in structural and moderating materials of reactor IVV-2, 25:60022
GOSSRAU, M., Absolute measurement of fluence and flux density of low-energy X- and γ-fields by semiconductor detectors, 25:57768
  Energy calibration of dosimeters for gamma and x-rays, 25:57859
GOSTEVA, T. S., Fine structure of the distribution function of ions in the plasma of a strong-current z discharge, 25:59024
GOTO, Eiichi, Quark--molecule calculations, 25:59344
GOTO, K., Chemically stable electrode material in liquid iron, 25:57441
GOTO, Seiichi, Device for measurement of time-resolved profiles of a line spectrum emitted from a plasma, 25:58989
GOTTSCHALK, W., Neutron-induced mutants of Pisum sativum, 25:57960
GOULDING, F. S., Detection of low energy x rays with Si(Li) detectors, 25:57816
  Pulsed feedback techniques for semiconductor detector radiation spectrometers, 25:57812
GOUSSARD, J., Survival of Azotobacter chroococcum following γ irradiation and ibenzmethyzine treatment, 25:58156
GOVORKOV, B. B., S-wave threshold amplitudes of neutral pion photoproduction on nucleons and PCAC hypothesis, 25:59373
GOYAL, Reva, Nonlinear scattering of partially coherent radiation by free electrons, 25:59225
GOZAK, V. P., Plasma heating at the electron cyclotron frequency, 25:58971
GOZANI, T., Application of photoinduced reactions to nuclear materials safeguards problems. Project summary report, July 1, 1970--June 30, 1971, 25:57704 (GULF-RT-A-10826)
GRADER, R. J., X rays from Puppis A and the vicinity of Vela X, 25:58561
GRAHAM, D. A., Characteristics of the radio pulses from the pulsars, 25:58545
GRANATA, G., Linear conversion of waves for an oblique incidence, 25:59082 (CEA-CONF-1803)
GRANT, W. A., Ion implantation of binary III--V semiconductors, 25:59168
GRASSO, F., Proton dechanneling in Ge probes, 25:59130
GRATTON, R., Producing 0.1-GeV ions by focusing ultrashort laser pulses on thin foils, 25:59341
GRAUL, J., Design criteria of radiation resistant semiconductor neutron detectors, 25:57746
GRAY, A. W., Minimum critical mass of ^{235}U reflected by natural uranium in water, 25:60220
GRAY, B. F., Application of Rayleigh--Schroedinger perturbation theory to H atom. II, 25:58811
GREBENNIKOV, R. V., Helium escape from irradiated borated materials with carbon--graphite matrix, 25:58378
GREBENYUK, G. G., Protection against reactor emergencies associated with reactivity perturbations, 25:60123
GRECHUKHIN, D. P., Two-quantum radiational capture of a slow neutron by a proton, 25:59527
GREDEL, H., Spectra and conversion factors of neutron calibration sources, 25:57676
GREEN, Clarence Rufus, Effects of bismuth impurity upon the critical field curve of superconducting tin, 25:58940
GREEN, E., Removal and replacement of boiling channels on prototype SGHWR, 25:60079
GREEN, H. S., Characteristic identities for generators of GL(n), O(n), and Sp(n), 25:59537
  Vector operators and polynomial identity for SO(n), 25:59538
GREEN, Ray E. L., Double-focusing quadrupole lens spectrometer and its use in the study of various nuclear reactions, 25:57901
GREENE, E. F., Kinetic energies of ionization products from collisions Ar--Ar and He--He, 25:58764
GREENSTEIN, J. L., Effective temperature, radius, and gravitational shift of Sirius B, 25:58511
GREENSTEIN, Jesse L., Spectra of white dwarfs with circular polarization, 25:58447
GREGORICH, David T., Complex Regge poles in πN backward scattering, 25:59495
GREGORY, Daniel L., Shuttle design starts in outer orbit, 25:60198
GREGORY, Michael V., Theoretical nuclear analysis of MH-1A: Cores 2 and 3, 25:60203 (AD-721019)
GREGUT, A., Phenix reactor, 25:60025
GREINER, W., Superheavy elements: extension of the periodic system, 25:59774 (AERE-Trans-1139)
GREINER, Walter, Superheavy elements and an upper limit to the electric field strength, 25:59554
GRESHAM, P. A., Variations in the relationships between total ^{59}Fe uptake and heme and nonheme fractions of spleen and bone marrow in irradiated mice and mouse radiation chimeras, 25:58119
GRESILLON, D., Ion waves excited by a grid in a collisionless plasma, 25:59095
GRIBBIN, J., Model for Centaurus X-3, 25:58552
GRIFFIN, R. E., Explanation for the 0^+ excited pairing state in actinide nuclei, 25:59809
GRIFFITHS, D. R., Outlook for nuclear power in Australia, 25:59919
GRIFFITHS, David J., Covariant derivatives of infinite-dimensional fields, 25:59582
GRIFFITHS, David W., Mandelaldehyde--2-hydroxyacetophenone isomerization, 25:57431
GRIFFITHS, J., Plutonium production in NPD: comparison between experiment and calculation, 25:60093 (AECL-3995)
GRIFFITHS, J. B., Note on neutrino-gravitational fields with positive energy density, 25:59589
GRIGOR'EV, Yu. G., Radiation safety of crew of Soyuz-9, 25:58006
GRIGORISHIN, I. L., Trajectories of charged particles in magnetic and electric fields with discrete potential distribution, 25:59231
GRIGORY, Stephen C., Testing six-inch thick flawed tensile specimen, 25:58219
GRINGAUZ, K. I., Velocity and temperature of solar wind, 25:58613
GRINSHTEIN, Yu. L., Radiation effects on glass and ceramics, 25:59147
GRINYUTE, G. A., Investigation of volatilization of MgO and

XUM

ZrO_2 in oxidizing atmospheres, 25:58345
GRISHAEV, I. A., Arrangement for direct nuclear reactions produced by electrons and gamma quanta up to 300 MeV, 25:59646
  Charged π-meson photoproduction on nuclei at E_0 = 560 MeV, 25:59248
GRISHAM, W. B., Production and crystal growth of isotopic rare-earth metals, 25:58184 (CONF-711002-, pp 181-90)
GRISHANOVA, S. I., Unified description of inelastic and quasielastic electron scattering from nuclei, 25:59869
GRISHIN, V. G., Coherent interactions of pions with nuclear emulsion at energies of 17 and 45 GeV, 25:59313
GRISHUKOV, V. A., Electric conductivity of electron-irradiated monocrystals of KCl--RbCl solid solutions, 25:59172
GRIST, S., Deuterium solvent isotope effects in methanol solution. I, 25:57427
GRITZNER, M. L., Prog. rpt. on fast reactor shielding, 8/71, 25:60055 (ORNL-TM-3573)
GROCHULSKI, W., Cross sections for reactions ^{89}Y(n,n')/sup 89m/Y and ^{89}Y(n,2n)^{88}Y, 25:59768
GROMOV, V. V., Accumulation of radiation defects in radioactive samples, 25:59170
  Influence of iron on the physicochemical state of radioelements in sea water, 25:57410
GRONCHI, M., Analytical result about co-operative spontaneous emission, 25:58812
GROS, M., Solar longitude dependence of proton-event delay time, 25:58612
GROSS, E. E., Elastic scattering of 40-MeV protons from ^{48}Ti, /sup nat/Cr, and ^{64}Zn: tabulated differential cross sections, 25:59739 (ORNL-TM-3591)
GROSSE, E., Coulomb excitation of Pb isotopes with α and ^{16}O beams, 25:59804
GROSSMAN, Lawrence, Enzymatic repair of deoxyribonucleic acid. IV. Mechanism of photoproduct excision, 25:57928
  Enzymatic repair of DNA. III. Properties of the UV-endonuclease and UV-exonuclease, 25:57935
GROSSWENDT, B., Geometric factors for angular correlation measurements with gamma radiation, 25:57733
GROZDANOVIC, J., Deoxycytidinuria in persons occupationally exposed to chronic irradiation, 25:58145
GRUBE, R., Current pulse shapes of semiconductor detectors, measured with an averaging technique, 25:57737
GRUEEBLER, W., Vector and tensor analysing powers of the D(d,p)T and D(d,n)^{3}He reactions at 10.0 and 11.5 MeV, 25:59700
GRUENAUER, F., Applicability of track detectors in neutron dosimetry, 25:57855
GRUENEWALD, Herbert, Powder metallurgical production of neutron-absorber units for nuclear reactors, 25:58255
GRUHN, C. R., Determination of trace elements in samples by nuclear scattering and reaction techniques, 25:57360
GRUJIC, P., Threshold laws for electron--atom collisions, 25:58745
GRUNDER, H., T(d Vector,n)^{4}He reaction with polarized deuterons at energies above 107-keV resonance, 25:59705
GRUNINGER, John, Hulthen transform functions for the excited states of two-electron atoms, 25:58713
GRUPEN, C., Electromagnetic interactions of high-energy cosmic-ray muons, 25:59246
GRUSCHINSKE, Juergen, Bellman's new approach to solution of Fredholm integral equations, 25:59110
GSCHNEIDNER, K. A. Jr., Low-temperature magnetic behavior of several oxides of gadolinium, 25:59198
GUAR, V. P., Effect of scattered light on the facula-to-photosphere contrast, 25:58587
GUARDIOLA, R., High-energy electron and proton scattering and deformation of ^{12}C nucleus, 25:59729
GUCZI, L., Isotope effect study in catalytic exchange of ethane, 25:57428
GUDA, M. G., T matrix for Hulthen potential, 25:59631
GUDERIAN, Ronald H., Characterization and fractionation of tobacco leaf transfer RNA, 25:60284 (RLO-2225-T-15-7)
GUECKEL, W., Calculations for production of ^{231}Pa and ^{232}U by neutron irradiation from ^{230}Th and ^{232}Th mixtures in the reactor with various irradiation conditions, 25:57479 (BMBW-FBK-71-6)
GUENIN, G., Anelastic properties of irradiated aluminum cold-worked at low temperature, 25:58338
GUENTHER, E., Manufacturing of fuel pellets with center holes, 25:58362
GUENTHER, Godehard A., Low power charge sensitive amplification and fast coincidence system for space application, 25:57821
GUENZEL, H., Uranium industry with realistic concepts of consumption, 25:58191
GUERNSEY, J. B., New tin--titanium alloy, 25:58234
GUEST, G. E., Containment in Tokamak and bumpy torus, 25:58961 (CONF-711016-1)
GUHA, J. P., Phase equilibria in system BaO--CeO_2, 25:58405
GUILLEMCT, M., Deformation of the electron distribution function under the influence of a large amplitude wave, 25:59012 (CEA-CONF-1833)
GUILLOT, P., Detection and alarm system for accidential nuclear excursions, 25:57780
GULIMOV, V. N., Temperature effect in 20 to 250°C range for certain, strictly regular, heterogeneous, U--H_2O critical assemblies, 25:60161
GULYAMOV, U. G., Inelastic pion--nucleon interactions with high multiplicity and the one-pion exchange model, 25:59496
GUMBAR, K. K., Photometric method for the determination of ultramicroquantities of thorium in rocks, 25:57342
GUMUCHIAN, A., Core assembly for nuclear reactors, 25:60253
  Fuel assembly with solid end-fitting, 25:60251
GUNION, J. F., Deuteron electromagnetic form factor, 25:59379
  Nonleading Regge behavior in νW_2 and the possibility of fixed poles with polynomial residues, 25:59381
GUNN, James E., Spectra of white dwarfs with circular polarization, 25:58447
GUPTA, B. K., Atomic wave functions useful for molecular calculations, 25:58710
GUPTA, C. K., Open aluminothermic reduction of columbium (Nb) pentoxide and purification of the reduced metal, 25:58202
GUPTA, G. P., Equivalence of gravitational red shift and temperature shift in Moessbauer effect, 25:59596
GUPTA, Jagdish C., Characteristics of irregular micropulsations Pi2 at high-latitude stations, 25:58903
GUPTA, Madan Lal, Energy dependent multichannel M- matrix fits to the available partial wave analyses of the anti KN system, 25:59476
GUPTA, S. P., Electrostatic plasma instabilities in the equatorial electrojet, 25:58900
GUPTON, E. D., Chest clearance of inhaled ^{60}Co oxide, 25:57995 (CONF-711013-1)
GUREVICH, I. I., Magnetic moment of Λ^0 hyperon, 25:59294
GUREVICH, S. M., Weldability and corrosion resistance of titanium--5 percent tantalum alloy, 25:58176
GURVITS, S. A., Method to calculate amplitudes for scattering of fast particles on nuclei, 25:59528
GUSEINOV, O. Kh., Identification of cosmic x-ray sources, 25:58530
GUSEINOV, R. E., Dynamical processes responsible for origin of coronal formations, 25:58573
GUSEV, V. V., Measurement of radiation heat release value in structural and moderating materials of reactor IVV-2, 25:60022
GUSTAFSON, Goesta, Dynamical model for πN resonance S_{11}(1525), 25:59486
GUTAY, L. J., Low mass I = 0 S-wave $\pi\pi$ phase shift, 25:59306
GUTKNECHT, D., Influence of trapping effects on Ge(Li) detector performance, 25:57798
GUTSCHE, C. David, Mandelaldehyde--2-hydroxyacetophenone isomerization, 25:57431
GUYON, E., Hydrodynamics and size effects in superfluid helium, 25:58915
GUYOT, Jean Charles, Measurement of atomic metastable densities in noble-gas plasmas created by nuclear radiations, 25:59003
GUZHAVIN, V. M., π^-p interactions at 3.25 GeV/c, 25:59314

H

HAAN, Oswald, Violation of ΔI absolute value = $^1/_2$ rule in non-leptonic decays, 25:59405
HAAS, Willy, Special vehicle for fighting damages in terrains contaminated with ABC substances, 25:57622
HAASE, J., Neutron dosimetry with radiation elements, 25:57776
HABEGGER, L, Spatial effects in transfer-function measurements of large nuclear reactor power systems, 25:60041
HABEGGER, L., Lyapunov stability of spatially-dependent nonlinear reactor system including an external primary heat exchanger, 25:60239
HABEGGER, Loren J., Parameter identification in a nonlinear reactor system, 25:60042
HABER, I., High-Mach-number turbulent magnetosonic shocks, 25:59044
HABERKANT, K., Coulomb excitation of Pb isotopes with α and ^{16}O beams, 25:59804
HABIBI, M., Precision measurement of lifetime and decay branching ratio of Λ^0 hyperon, 25:59260
HACK, M., Activity phase of CH Cygni during 1967 to 1970, 25:58482
HACKER, H., Measuring the blood flow through the brain with the aid of ^{133}Xe, 25:58058
HAEFELE, W., Basic problems of the development of fast breeder reactors, 25:60008 (CONF-710922-4)
  Technical and scientific position as well as prospect for nuclear energy in the engineering of the Federal Republic of Germany. II, 25:60012 (JUL-775-RG)
HAERENDEL, G., Ambipolar diffusion along magnetic field lines in presence of an electric current, 25:58862
HAEUSLER, B., Solar particle event of March 1970, 25:58892
HAGEN, E. W., Reactor availability and station reliability for continuity of service, 25:59918
HAGLER, M. O., Global temperature effects of the use of fusion energy and the fusion torch, 25:58956
HAGLER, William S., Eye tumor identification tests using semiconductor detectors, 25:58064
  Medical problems in eye tumor identification, 25:58063
HAGN, E., Measurements of NMR on oriented ^{192}Ir and /sup

191m/Ir in Ni and Fe host lattices, 25:59807
HAGSTRUM, H. D., Nonradiative processes at solid surfaces, 25:58692
HAHN, Linus K., Mass flow rate measuring utilizing the scattering cross-section of a material for fast neutrons, 25:57667
HAHN, Yukap, Generalized eikonal approximation, impact phase averaging, and multiple hard collisions, 25:59610
HAIGHT, R. C., Polarization transfer in reaction T(p,n)^{3}He at 0° for E/sub p/ in range 3 to 16 MeV, 25:59695
HAIRION, Jean-Pierre, Techniques of continuous measurement of radioactive fission gases evolved in fuel elements, 25:57344 (CEA-R-4218)
HAKEN, N., Current pulse shapes of semiconductor detectors, measured with an averaging technique, 25:57737
HALBERT, M. L., Review of experiments on nucleon--nucleon bremsstrahlung, 25:59241 (CONF-710915-2)
HALBLEIB, J. A., Magnetic Compton spectrometer for high intensity pulsed gamma ray environments, 25:57813
HALDAR, B. C., Substoichiometric determination of nickel in steel by neutron activation analysis, 25:57381
  Substoichiometric determination of selenium by neutron activation analysis, 25:57380
HALL, B. H., Proposed method for a search for C violation via rho^0 interference in ω decay, 25:59552
HALL, Douglas S., UBV photometric study of HS Herculis, 25:58452
HALL, R. N., High purity germanium for detector fabrication, 25:57787
HALLER, E., Channels on surfaces of Ge(Li)-diodes and their influence on x-ray and electron spectra, 25:57797
HALLIDAY, I. G., Signature, factorization, and unitarity in multi-Regge model, 25:59611
HALLIDY, W. H., Radiation scattering in Einstein--Maxwell theory, 25:59606
HALPERN, L., Sources and detection of gravitational radiation of high frequency, 25:59604
HAMAGUCHI, Shunichi, Trial of No. 1 plant in Mihama nuclear power station, 25:59927
HAMAMOTO, Ken, Positive scintiphotography of cancer of the liver with ^{67}Ga citrate, 25:58045
  Studies on liver function test with ^{131}I BSP monoiodide and scinticamera, 25:58042
HAMESCH, Muwaffak, Investigation and preparation of spherical doped UO$_2$ fuel particles, 25:58347 (JUL-730-RW)
HAMILTON, C. C., Programmable data acquisition interface, 25:59665
HAMILTON, David, Power from the fast breeder, 25:60029
HAMILTON, Maureen, Atomic absorption spectrophotometric determination of molybdenum in fertilizers, 25:57306
HAMMERLI, Martin, Hydrogen/deuterium separation factors on cathode and diffusion sides of 25 percent Ag--Pd foils, 25:57538
HAMMOND, R. H., Kinetic energies of ionization products from collisions Ar--Ar and He--He, 25:58764
HAMMOU, A., Electric conductivity of solid solutions of (ThO$_2$)$_{0.75}$--(CeO$_2$)$_{0.25}$ at high temperature, 25:58368
HAN, M. Y., Mechanism for CP nonconservation, 25:59539
HANKIN, B. C., Numerical solution of the unsteady radiative-transfer equation, 25:59114
HANKINS, T. H., Microsecond intensity variations in radio emissions from CP 0950, 25:58562
HANLE, H., Detection of high energy γ-quanta with a pair-spectrometer, 25:57904
HANNA, H. A., Static detector, 25:60275 (MHSMB-24)
HANNABUSS, K. C., Localizability of particles in de Sitter space, 25:58660
HANSEN, Carl, ISIS: program for computerized fission data analysis, 25:59773 (AD-721481)
HANSEN, Carl J., Element production in simple helium burning, 25:58508
HANSEN, L., Determination of atmospheric parameters for G and K giants, 25:58481
HANSEN, Luisa F., Spectra of fast neutrons from water pulsed with 14-MeV neutrons, 25:59674
HANSEN, N., 1971 results for intercomparison of analytical methods for ^{137}Cs and ^{134}Cs used at Scripps with methods used at 56 other institutions, 25:57348 (TID-25777)
  Natural cesium in sea water, 25:57301 (TID-25776)
HAOT, J., Characterization of small size lymphoid cells in irradiated and normal mouse bone marrow, 25:58120
HARA, Hiroshi, Heterotopic bone formation in the lung, 25:58133
HARARI, Haim, Electroproduction of π^0, 25:59346
HARATANI, Thomas, Introduction to x-coefficients and a tabulation of their values, 25:59881
HARATYM, Z., Excitation of isomeric activities in Rb, Y, Pd, Cd, W, Os, and Pb using 14.8-MeV neutrons, 25:59797
HARBINSON, G. S., Low-angle scattering of energetic ions from an amorphous surface, 25:58689
HARBOTTLE, J. E., Contribution to the discussion on nucleation, 25:58333
  Influence of HVEM irradiation on neutron induced voids in Ni, 25:58330
HARBST, Hans, Clinical importance of the study of the lymphatic system with radioisotopes, 25:58055
HARDORP, Johannes, Angular momentum and short-term directional fluctuations of the solar wind from vela 3 data, 25:58581
HARDY, Edward P. Jr., Prog. rpt. on Fallout Program, 6/71--9/71, 25:57980 (HASL-245)
HARDY, W. R., Stirling cycle cryogenic cooler used with accelerator for radiation effects in thin films, 25:59160
HARE, M. G., Binding energy of the deuteron, 25:59526
  Binding energy of the singlet deuteron, 25:59518
HARLEY, P. H., Failures of threaded fittings and fasteners at nuclear facilities, 25:57618 (ORNL-TM-3570)
HARMANCI, Ali Emre, Versatile analog device for identifying charged particles by their energies and ionizing powers, 25:57722 (CEA-R-4183)
HARMSEN, D. M., Improved partial wave analysis of anti KN → anti KN from 800 to 1200 MeV/c, 25:59293
HARRAH, L. A., Nonlinear responses of poly(vinyl toluene) plastic scintillators at high excitation doses, 25:57765
HARRINGTON, David R., Eikonal approximation for inelastic processes, 25:59330
HARRINGTON, Timothy M., Instrument for the measurement of auroral electrons and protons, 25:57790
HARRIS, E. G., Containment in Tokamak and bumpy torus, 25:58961 (CONF-711016-1)
HARRIS, Hobart B., Log of Hydrologic Test Well 1, Tatum dome area, Lamar County, Mississippi. Dribble-6, 25:57562 (USGS-474-110)
  Log of Hydrologic Test Well 2, Tatum dome area, Lamar County, Mississippi. Dribble-7, 25:57563 (USGS-474-111)
HARRISON, A. W., Study of (4-1) and (5-2) hydroxyl bands in night airglow, 25:58902
HARRISON, Edward R., Outward drift of the interstellar medium in disk of Galaxy, 25:58649
HARRISON, M. F. A., Cross sections for electron-impact ionization of multi-electron ions. II, 25:58769
  Cross sections for electron-impact ionization of multi-electron ions. I, 25:58774
HARRISON, R. W., SNAP-8 refractory boiler development, 25:60138 (N-71-19497)
HARRISON, W. Craig, Fusion reactions in self-colliding orbits, 25:59078
HARSTAD, David N., Operational amplifier models for computer-aided circuit analysis, 25:60289 (SC-RR-710628)
HART, R. R., Disorder produced in SiC by ion bombardment, 25:59171
HARTLEY, B. J., Generalized Veneziano model for $\pi^- p \to K^0$ anti K^{0}n, 25:59492
HARTMANN, U., Influence of adrenal cortex total extracts on radiation sickness, 25:58035
HARVEY, M., Dependence of Hartree--Fock solutions in sd-shell nuclei on spin-dependent forces, 25:59878
HASEGAWA, A., Benchmark test by various cross section sets for fast reactor analysis in Japan, 25:60210 (JAERI-Memo-4406)
HASEGAWA, Akira, Plasma instabilities in the magnetosphere, 25:58895
HASEGAWA, Susumu, Effects of x rays and electrons on malignant tumors, 25:58083
HASHIMOTO, Hiroshi, Torus device for thermonuclear fusion equipment: JFT-1, 25:59079
HASHITANI, Hiroshi, Chemical analysis of the fuel solution of JRR-1, 25:57320
HASHIZUME, T., New thermoluminescence dosimeter of high sensitivity using a magnesium silicate phosphor, 25:57841
HASKELL, T., Study of (d + x)/sup n/p/sup m/ configurations using the SU$_3$ group, 25:58787
HASLAM, C. G. T., Are the galactic loops supernova reminants, 25:58628
HASSIB, G., Neutron dose estimation using a natural uranium fission fragment track personnel dosimeter, 25:57854
HASTIE, R. J., Nonadiabatic behavior of radiation-belt particles, 25:58907
HATTORI, Chuichiro, Chiral invarient Lagrangian with massive gauge fields, 25:59449
HAUGHTON, G., Characterization of small size lymphoid cells in irradiated and normal mouse bone marrow, 25:58120
HAUSER, M. G., Experimental study of ω neutral decays, 25:59320
HAVENSTEIN, Paul L., Target for the AEC'S reactor standards program in the instrumentation and control area, 25:60180
HAWKESWORTH, M. R., Polaroid positive film in neutron radiography, 25:57691
HAYAKAWA, S., Observation of cosmic soft X rays, 25:58548
HAYASHIBE, Shogo, Energy levels of ^{142}Nd, 25:59821
HAYATSU, Ryoichi, Origin of organic matter in early solar system. IV, 25:58576
  Origin of organic matter in early solar system. III, 25:58575
HAYES, D. J., Leak detection in sodium heated boilers, 25:57632
  Observations on particulates in a sodium loop, 25:58170 (RD/B/N-1998)
HAYES, Everett G., Development of an electric manometer tester, 25:60286 (SC-DR-710418)
HAYES, S., Branching ratio for decay of phi mesons into lepton pairs, 25:59310
HAYWOOD, L. R., Status of heavy water moderated reactor,

25:60019

HAZARD, C., Accurate radio and optical positions of 3C 273B, 25:58566

HAZELTINE, R. D., Fourier transform methods in linear transport theory, 25:59121

HAZELTON, W. S., Sensitized stainless steel in Westinghouse PWR nuclear steam supply systems, 25:59886 (WCAP-7735)

HEAGNEY, J. M., Preparation of isotopic accelerator targets, 25:59636 (CCNF-711002-, pp 101-7)

HEAP, S. R., Observations of C and Of stars, 25:58483

HEARN, A. G., Aspects of non-LTE physics of He atom in hot stars, 25:58472

HEARN, Dwight D., Frequency distribution of radiation emitted from excited atomic systems, 25:58807

HEATON, John Fildes, Improvements in and relating to nuclear reactor fuel elements, 25:60084

HEBARD, Arthur Foster, Search for fractional charge using low temperature techniques, 25:59240

HEBERT, C. J. D., Sensitivity of nuclear emulsion at very low temperature, 25:57829

HEBERT, J., Sensitivity of nuclear emulsion at very low temperature, 25:57829

HECKMANN, P. H., Lifetimes and relative initial-state populations of some hydrogen atomic states using beam--foil spectroscopy, 25:58722

HEDGE, W. D., Laboratory quality control computer program, 25:57611 (CTC-51)

HEERSCHAP, M., Purification of vanadium and production of vanadium single crystals through zone melting, 25:58192

HEILMANN, H.-P., Radiation planning as prerequisite in magavolt therapy, 25:58007

HEINLOTH, K., Electroproduction of π^0-mesons on protons in backward direction, 25:59353

HEINRICH, R. R., Chemical Engineering Division. Cross sections and burnup semiannual report, January--June 1971, 25:60035 (ANL-7824)

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HEITZ, Ch., Chemical consequences of reaction $^{238}U(n,\gamma)^{239}U$, 25:57488

HEKKALA, Barney, Radiation monitoring, 25:60120

HELLAND, J. A., Isospin invariance in reaction np $\rightarrow$ π^0d, 25:59268

HELM, Frederick, Tumors of skin. XII, 25:58037

HELMINGER, Paul, Rotational spectra of NH_3 and ND_3 in the 0.5-mm wavelength region, 25:57424

HELMIS, G., Electrodynamics of turbulent moving electrically conducting media with consideration of the hall effect, 25:58849

HENCK, R., Influence of trapping effects on Ge(Li) detector performance, 25:57798

HENDERIXSON, W. H., SNAP-8 refractory boiler development, 25:60138 (N-71-19497)

HENDLINGER, Evzen, Installation of neutron-generator NA-2, 25:59676

HENDRY, Archibald W., Equivalence of Regge and optical models, 25:59421 (CCC-2009-30)

HENIS, J. M. S., Kinetic energies of ionization products from collisions Ar--Ar and He--He, 25:58764

HENNEBERGER, W. C., Inequivalence of representations of commutation relations obtained by orthogonal transformations in field theory, 25:59567

HENOUX, J. C., Isotopes of magnesium in the solar atmosphere, 25:58597

HENRY, C. Daniel, Theoretical nuclear analysis of MH-1A: Cores 2 and 3, 25:60203 (AD-721019)

HENSCHEID, J. W., Summary of ETR Critical Facility safety analysis information, 25:60149 (ANCR-1002)

HENSLEY, D. C., System for multiparameter pulse height analysis with repeated use of a single, fast ADC, 25:59668

Use of arrays smaller than implied by the range of descriptors for multiparameter pulse height analysis, 25:59667

HENSON, Sylvestus Hyatte, Experimental study of γ-ray transition probabilities with the recoil-distance and the delayed-coincidence techniques, 25:59771

HEPPNER, J. P., Rocket measurements of magnetic fields associated with visual aurorae, 25:58857

HERBIG, G. H., Spectrum of LkHα-101 in near-infrared, 25:58504

HEREMANS, J. F., Serum concentrations of immunoglobulin in pigs after exposure to γ ray, 25:58104

HERLER, Horst, Mechanism of the radiolysis of cyclohexane, 25:57473

HERMANN, G., Probability for producing K vacancies in violent ion--atom collisions at keV energies, 25:58756

HERRERA, Alfredo, Supplementary trivial equations in Penrose-Newman formalism, 25:59586

HERTOGEN, J., Instrumental neutron activation analysis of rocks with a low-energy photon detector, 25:57387

HERTZBERG, A., Use of long-wavelength, high powered lasers for controlled thermonuclear fusion, 25:59054 (MATT-782)

HERZBERG, G., Beutler--Fano shape in the predissociation of H_2, 25:58717

HERZENBERG, A., Compound states in atoms and molecules, 25:58804

HESKIA, S., Massive vector mesons with gauge-invariant Lagrangian, 25:59555

HESS, George B., Critical velocities in superfluid He flow through 10-μm-diameter pinholes, 25:58921

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HEUBERGER, A., Gamma energy resolution of multiplying detectors, 25:57748

HEUSGHEM, C., Liege anthropogammameter and its clinical use, 25:57764

HEWSON-BROWNE, R. C., Extrusion of plasma into confined magnetic field of line dipole, 25:58859

HEYDA, D., Application of multi-Regge model to reaction $\pi^-p \rightarrow p\pi^+\pi^-\pi^-\pi^0$ at 13 and 20 GeV/c, 25:59300

HEYMANN, D., Distribution of ^{222}Rn on surface of moon, 25:58680

HICKEL, B., Transient species in the pulse radiolysis of periodate ion in neutral aqueous solutions, 25:57466

HICKS, G. M., π^+p elastic scattering at 3.6 GeV/c, 25:59292

HICKS, Harry Richard, Analysis of deuteron reactions using amplitudes with anomalous thresholds, 25:59514

HIEBERT, J. C., Programmable data acquisition interface, 25:59665

HIERSEMANN, R., Development of nuclear power technical school, 25:59916

HIGBIE, James Howard, Solutions of the gravitational--scalar field system, 25:59587

HIGGINS, C. S., Interstellar scattering and low-frequency spectrum of PSR 0833-45, 25:58540

HIGGS, L. A., Survey of microwave radiation from planetary nebulae, 25:58544

HIGUCHI, Niroku, Nuclear-powered ship Mutsu, 25:60205

HIGURASHI, Makoto, In vitro chromosomal radiosensitivity in Fanconi's anemia, 25:57973

HILF, E., Thermodynamics of hyperon stars, 25:58521

HILGARTH, M., Irradiation changes in epithelium of the Cervix, 25:58140

HILL, A. J., Remote decontamination of equipment in a radiochemical separations plant, 25:57517 (DP-1266)

HILL, Graham, Four suspected spectroscopic binaries in Pleiades, 25:58458

HILL, J. G., Numerical solution of the unsteady radiative-transfer equation, 25:59114

HILL, J. M., Gravitational deflection of radio waves by Sun, 25:58662

HILL, Paul R., Thermionic converter cells for nuclear reactor, 25:60197

HINCKLEY, A. Dexter, Infestation of irradiated white oaks by the solitary oak leafminer, Cameraria hamadryadella (Lepidoptera: Gracilariidae), 25:58092

HINE, Michael John, Acoustically induced vibrations of slender rods in a cylindrical duct. I and II, 25:57621 (TRG-Report-2141)

HINNERS, N. W., New Moon, 25:58677

HINS, Allan G., Manufacture of clad fissionable foils for ZPR measurements, 25:58180 (CONF-711002-, pp 70-6)

HIRAGA, M., Some experimental data conflicting with the explosion model in gaseous bromides, 25:57501

HIRASHIMA, Yoshiyuki, Separation factors in a europium chloride--samarium chloride--neodymium chloride--di(2-ethylhexyl)phosphoric acid system, 25:57543

HIRATA, Mitsuho, Conceptual design of the reactant flow loop for fissiochemical studies, 25:57613 (JAERI-Memo-4446)

HIRAYAMA, Tadashi, Abundance of helium in prominences and in the chromosphere, 25:58602

HIRONS, Thomas J., Effect of condensing the spatial mesh on the accuracy of fast breeder fuel-cycle analyses, 25:60100

HIROSE, T., Antiproton--proton charge exchange and elastic scattering at 232 MeV, 25:59266 (SJC-P-71-1)

HIROTA, Isao, Experimental fast reactor Joyo, 25:60177

HIRSCH, Herbert M., Setting test intervals and allowable bypass times as a function of protection system goals, 25:60053

HITCHCOCK, J. A., New high-stability nickel alloy thermocouple, 25:57876

HLEVCA, B., Radioprotective effect of ethylene glycol on bacteria, 25:58157

HOBART, James L., Power meter for measurement of radiation, 25:57761

HOBART, R. L., Control of a continuous ion exchange system, 25:57510 (ARH-SA-82)

HOBBS, R. H., Intermediate boson. II, 25:59410

HOBSON, D. O., Deformation and rupture behavior of light-water reactor fuel cladding, 25:60118 (ORNL-4727)

Tubing fabrication parameters and their application to texture control in zircaloy tubing, 25:58186 (ORNL-TM-3500)

HOBSON, Robert R., Thermionic converter cells for nuclear reactor, 25:60197

HOBST, L., Prestressing of pressure vessels of nuclear power plants with wrapped reinforcement, 25:60063

HOCH, M., Thermodynamics of titanium alloys. II. The Ti--Mo system, 25:58265

HOCKNEY, R. W., Measurements of collision and heating times in a two-dimensional thermal computer plasma, 25:59033

HODGE, V. F., 1971 results for intercomparison of analytical methods for ^{137}Cs and ^{134}Cs used at Scripps with methods used at 56 other institutions, 25:57348

(TID-25777)
HOEHNE, K., Electroproduction of π^0-mesons on protons in backward direction, 25:59353
HOEKSTRA, R., Present state of analysis of Nd I and Nd II, 25:58705
HOELKE, C. W., Damaged regions in neutron-irradiated and ion-bombarded Ge and Si, 25:59140
HOERZ, G., Nitrogen solubility in metals of high melting points, 25:58249
HOFER, W. O., Depth distribution of characteristic x-ray production in Cu by 12- to 30-keV electrons, 25:58685
HOFFMAN, C. M., Use of neutron activation analysis for the characterization of paper, 25:57374
HOFFMAN, Mary V., Effect of thorium on Ce^{+3} phosphors, 25:59185
HOFSTADTER, R., Nuclear charge distributions from electron scattering: barium and neodymium, 25:59793
HOGAN, J. T., Containment in Tokamak and bumpy torus, 25:58961 (CONF-711016-1)
HOGG, Harold A., Crossed-field electron injector for an electron accelerator, 25:59659
HOINKIS, E., Chemical aspects of reactor safety, 25:60116 (HMI-B-113)
HOLLARD, D., Cellular ultrastructure and mitotic index of lymphocytes of leukemia during treatment by irradiation, 25:58131 (CEA-CONF-1768)
HOLLIDAY, John Bertram, Power plants, 25:60141
HOLLIDAY, Robin, Genetic repair and synthesis of nitrate reductase in U. maydis after uv irradiation, 25:57955
HOLLOMAN, S. B., Range-energy calculations of heavy ions in Si, 25:59116
HOLMBERG, M., Prompt anti ν in spontaneous and neutron fission of ^{238}U, 25:59806
HOLMBERG, P., $^{27}Al(p,\gamma)^{28}Si$ resonances, 25:59762
  Energy determinations of gamma rays and new weak transitions in decay of ^{56}Co, 25:59763
  Nuclear levels and transitions in odd Cu isotopes. II, 25:59764
HOLMBERG, Robert W., ESR study of gamma-irradiated single crystals of $KHCO_3$ at 77°K, 25:57471
HOLMES, J. J., Biaxial stress rupture properties of annealed 316 stainless steel after EBR-II irradiation, 25:58297 (HEDL-TME-71-72)
HOLMES, J. M., Cask and waste container cooling studies, 25:57706 (ORNL-TM-3545)
HOLZER, T. E., Interaction between interstellar helium and the solar wind, 25:58855
HOLZMAN, Melvyn A., Statistical atom model based on a local Coulomb approximation, 25:58815
HONJO, Ichio, Positive scintiphotography of cancer of the liver with ^{67}Ga citrate, 25:58045
HONZATKO, J., Linear polarization of low-energy capture γ-rays from $^{35}Cl(n,\gamma)$ reaction, 25:59745
HOOFT, G.'t, Renormalization of massless Yang--Mills fields, 25:59571
HOOPER, R. A. E., Study of the electrochemistry and morphology of electro-deposited nickel--molybdenum alloys, 25:58256
HOPMAN, H. J., Production of a very quiescent plasma in skipping magnetic fields, 25:59055
HORELICK, D., Proportional wire chamber electronics system utilizing CAMAC, 25:59656
HORIKAMI, Kunihiko, Calculation code for thermal neutron multi-group reactor constants: THERMOS-MUG, 25:60225 (JAERI-Memo-4394)
HORIUCHI, Hiroyuki, Crystallography of V/sub n/O/sub 2n-1/ (3 less than or equal to n less than or equal to 8), 25:58393
HORIUCHI, Tetsuo, Performance analysis of BWR emergency core cooling system designed for Shimane nuclear power station of Chugoku Electric Power Company, 25:59897
HORN, G., Leak detection in sodium heated boilers, 25:57632
HORVATH, Pavel, Fast electronic modules for nuclear physics experiments, 25:57786
HORVATH, Z., Field theory of spin-two mesons and an equivalence theorem, 25:59570
HORWITZ, L. P., Duality and representation mixing in non-chiral U(6) x U(6), 25:59549
HOSEMANN, R., Neutron dosimetry with radiation elements, 25:57776
HOSHI, Michio, Precipitation of some actinide element complex ions by using hexammine Co(III) cation. III, 25:57403
HOUDAYER, A., Decay of ^{68}As, 25:59747
HOUGEN, Merritt L., Magnetohydrodynamic instabilities in weakly ionized, radiating plasma, 25:59066
HOUSE, Reginald K., Scintillation scanning of liver cell adenoma, 25:58046
HOUSTON, J. T., Effects of structural imperfections on voids in aluminum, 25:58298 (ORNL-TM-3493)
HOUTMAN, J. P. W., Mercury in the environment, 25:57392
HOVESTADT, D., Solar particle event of March 1970, 25:58892
HOWARD, Hillard H., Determination of ^{12}Be ground-state mass, 25:59716
HOWARD, J. M., K- and L-shell electron shake-off in the beta decay of ^{204}Tl, 25:59792
HOWERTON, R. J., Evaluated nuclear cross section library, 25:59783 (UCRL-50400(Vol.4))
HOYER, P., Crossing and isospin symmetric description of anti KN $\pi\pi$ anti Λ system using generalized Veneziano model, 25:59488
HOYLE, F., Nature of mass, 25:58667
HREBIK, J., Magnetic transition points in U_3Bi_4 and UGa_2, 25:59190
HRUBESH, Lawrence W., Microwave rotational spectroscopy applied to trace-gas pollutant monitoring, 25:60294 (UCRL-73197)
HSIEH, E. J., Radiation hardness of a new magnetic thin-film recording system, 25:57908
HSIEH, M. S., Projective solution of integral equations arising in electric and magnetic field problems, 25:59214
HSIEH, Mei-whey, Cell line initiation from cord blood leukocytes treated with viruses, chemicals, and radiation, 25:57921
HSU, C., Lyapunov stability of spatially-dependent nonlinear reactor system including an external primary heat exchanger, 25:60239
  Spatial effects in transfer-function measurements of large nuclear reactor power systems, 25:60041
HSU, Chun, Parameter identification in a nonlinear reactor system, 25:60042
HUANG, Kerson, Scaling law for deep-inelastic hadronic scattering, 25:59428
HUBBARD, G. Scott, UBV photometric study of HS Herculis, 25:58452
HUBER, P., Investigation of $^6Li(d\ Vector,\alpha)^4He$ reaction, 25:59737
HUBERMAN, B. A., Energy of a tachyon in a magnetic field, 25:59388
HUCHRA, John, Comments on the instability strip for halo population variables, 25:58440
HUDAK, Julia S., Handbook for technologists of nuclear medicine, 25:58049
HUDGIN, Richard Henry, Coordinate-free relativity, 25:59588
HUDSON, J. A., Void formation during ion irradiation of metals at elevated temperatures, 25:58320
  Void formation in nickel, 316 steel, and nimonic PE16 during 20 MeV C^{++} irradiation, 25:58322
HUENIG, R., Angiography, scintillation scanning, and ultrasound tomography of liver, 25:58044
HUESTIS, D. L., Selection rule for Σ^+ in equilibrium Σ-transitions in electron--molecule collisions, 25:58732
HUFFMAN, A. H., Interaction current contributions to parity non-conserving nuclear γ-transitions, 25:59856
HUG, O., Relevance of chromosome aberration yields for biological dosimetry after low-level occupational irradiation, 25:58015
HUGHES, B. M., Abundance of excited O^+ ions produced by electron impact on O_2, CO_2, N_2O, NO_2, and H_2O, 25:58763
HUGHES, M. P., Absorption-line study of galactic H at 21 cm, 25:58651
HUGHES, Walter L., Prog. rpt. on transport and catabolism of proteins, techniques and mechanisms, final, 3/65--2/70, 25:60277 (NYO-3515-5)
  Uptake of ^{125}I labeled rat gamma globulin by intestinal epithelial cells in the neonatal rat, 25:60278 (NYO-3515-6)
HUMMER, D. G., Radiative transfer in spherically symmetric systems. II, 25:58510
HUNT, D. C., Plutonium metal criticality measurements, 25:57718
HUNT, Douglas C., Collision probability calculations of multiplication factors for lattices, 25:60230
HUNT, J. H., Simple ionization measuring device for bubble chamber pictures, 25:57825 (RPP/H-81)
HURLOCK, S. C., Energy levels and molecular constants of $^{12}C_2H_2$, $^{12}C_2D_2$, and $^{12}C_2HD$, 25:57433
HURST, C. A., Boson calculus for the orthogonal and symplectic groups, 25:59534
HURST, James Norman, Power plants, 25:60141
HUTH, G. C., In vivo measurement of plutonium and other very low energy emitters, 25:57770
HWA, Rudolph C., Flat proton spectrum and its implications, 25:59511
HYAMS, B. D., Reaction $\pi^-p \to K^+K^-n$ between 988 and 1100 MeV invariant KK mass, 25:59301
HYATT, W. D., Low-temperature annealing of electron-irradiated germanium, 25:59132
HYDE, A. T., Application of photoinduced reactions to nuclear materials safeguards problems. Project summary report, July 1, 1970--June 30, 1971, 25:57704 (GULF-RT-A-10826)

I

IANOVICH, E., Behavior of radioactive Re atoms in thermal annealing of crystalline Re salts, 25:57497
IBEN, Icko Jr., Comments on the instability strip for halo population variables, 25:58440
ICHIKAWA, Michio, Uranium dioxide fuel pin elongation behavior under irradiation, 25:58414
ICHTCHENKO, G., Plasma heating at the lower-hybrid resonance, 25:58960 (CEA-CONF-1831)
IGI, K., Veneziano model and unitarity sum rules, 25:59462
IGLITSYN, M. I., Effect of neutron and alpha-particle irradiation upon physical properties of α-SiC, 25:59154

XUM

IGNATOV, D. V., Heat resistance of nickel-base alloys, 25:58224
IIJIMA, S., Benchmark test by various cross section sets for fast reactor analysis in Japan, 25:60210 (JAERI-Memo-4406)
IKEDA, Yoko, Study on detection methods of ^{14}C-labelled compounds, 25:57752
IKUTA, Kazunari, Adiabatic compression of plasma in trapped-particle-free stellarator, 25:58964
  Stability of relativistic plasma, 25:59064
IL'IN, L. A., Comparative behavior of ^{89}Sr and ^{140}Ba in skin, 25:57917
IL'IN, R. N., Formation and Lorentz ionization of highly excited atoms, 25:58691
IL'IN, V. G., Protection of animals against injury by nuclear weapons, 25:58026
IL'INA, E. V., Plasma parameters and the population of excited atomic states in a low-current helium arc, 25:59017
IL'INSKII, V. N., Cosmic gamma-ray measurements in range 0.3 to 3.7 MeV, 25:58831
IL'KOVA, S. B., Polarographic determination of Bi, Cu, Pb, Cd, Zn as impurities in rare earth preparations, 25:57311
IMAI, Ryukichi, Nuclear power as source of energy in Japan, 25:59904
IMAI, Takashi, Pitch-angle distribution of fast electrons, 25:58904
IMAMURA, Masakatsu, Electron microscopic study on acute thymic involution induced by polyoma virus infection, 25:58114
IMAMURA, Nobutaka, Effect of partial marrow shielding on hematopoietic recovery in heavily irradiated mice, 25:58124
IMHOF, W. L., Performance of large germanium detectors at elevated temperatures for satellite applications, 25:57791
IMLAY, R., Branching ratio for decay of phi mesons into lepton pairs, 25:59310
IMOTO, Shosuke, Preparation of anhydrous uranium tetrachloride and measurements on its magnetic susceptibility, 25:57419
INAMI, T., Dual structure of anti KN scattering in intermediate energy region, 25:59504
INAMURA, Kiyonari, Real time dose distribution display by digital computer, 25:58078
INDRA, J., Development of pressure vessel steels for Czechoslovak Nuclear Stations, 25:58216 (ZJE-106)
INGEBRETSEN, R. B., Phenomenology of muon showers underground, 25:59247
INNES, F. R., Reduced matrix elements and representation of wave functions, 25:58789
INOMATA, A., Breaking of scale invariance, Regge trajectories, and dyons, 25:59430
INOUE, K., Measurement of the plasma current distribution in a tokamak device with alpha-particles injected transverse or parallel to the toroidal axis, 25:58980 (JAERI-Memo-4531)
INOUE, Masasuke, Earthquake response analysis of nuclear power plant, 25:57598
INOUE, Toru, Electric facilities of Mihama nuclear power station Kansai Electric Power Co, 25:59930
INUISHI, Y., Annealing behavior of bulk n-GaAs irradiated by electrons, 25:59156
IOFA, M. Z., Bounds on the elastic amplitude in nonlocalizable field theories, 25:59565
IONESCU, E., Determination of the concentration of ^{59}Fe in the coolant water of VVR-S reactor, 25:57346 (IFA-FR-82)
IONESCU, G., Determination of the concentration of ^{59}Fe in the coolant water of VVR-S reactor, 25:57346 (IFA-FR-82)
IONOV, N. I., Desorption of ytterbium and neodymium from tungsten by an electric field, 25:58230
IPATOV, V. A., Methods of plasma investigation by microwave reflection, 25:58995
IPOHORSKI, M., Interaction between radiation damage and coherent precipitates, 25:59163
IRIE, Minoru, Radioimmunoassay for canine growth hormone, 25:57909
IRIKO, Teruo, Electric facilities of Mihama nuclear power station Kansai Electric Power Co, 25:59930
IRVINE, J. M., Shell-model data from a realistic N--N interaction. III, 25:59723
ISAICHEV, V. I., Structure of anomalously coarse grains in secondary recrystallization of tungsten foils, 25:58279
ISAKOV, Lev Mikhailovish, Determining the content of chemical elements or isotopes thereof in a specimen by utilizing the effect of recoilless resonance absorption or scattering of gamma rays, 25:57354
ISAKSSON, S.-E., Hot isostatic pressing, 25:58197
ISAWA, Toyoharu, Comparison of radioaerosol versus radioxenon inhalation procedures in obstructive lung disease and pulmonary embolism, 25:58040 (UCLA-12-834)
ISBASESCU, A., Absolute measurement of ^{239}Pu fission cross-section for 2200 m/sec neutrons, 25:59777 (IFA-NR-33)
ISE, Takeji, Calculation code for thermal neutron multi-group reactor constants: THERMOS-MUG, 25:60225 (JAERI-Memo-4394)
ISHIDA, Kazuko, Study on detection methods of ^{14}C-labelled compounds, 25:57752
ISHIDA, Masayoshi, New approximation in the calculation of collision probabilities in cluster-type fuel lattices, 25:60231
ISHIGURO, Y., Benchmark test by various cross section sets for fast reactor analysis in Japan, 25:60210 (JAERI-Memo-4406)
ISHII, Teruo, Effects of Mn, Si, Cr, and Ni on reaction of solution and precipitation of Nb nitride in Fe austenite, 25:58268
ISHII, Toshio, Conceptual design of the reactant flow loop for fissiochemical studies, 25:57613 (JAERI-Memo-4446)
ISHIKAWA, Daizi, Effects of γ irradiation on ^{51}Cr-labeled red blood cells, 25:58136
ISHIKAWA, Michio, Feedback behavior of the prompt moderator heating effect, 25:60179
ISHIKAWA, Nobuyuki, Radiosensitivity of the radiation induced aminopterin resistant yeast cells, 25:57927
ISHIKETA, Tadashi, Estimation of coefficient of luminescence in organic scintillator by using digital computer, 25:57753
ISHIMURA, Tsutomu, Device for measurement of time-resolved profiles of a line spectrum emitted from a plasma, 25:58989
ISHIZAKA, Masatsuna, Examination of blood counts on radiological technicians in Japan, 25:58134
ISHIZUKA, Takao, Thermal and hydrodynamic transfer functions of BWR core, 25:60038
ISIHARA, A., Statistical mechanics of an electron gas in a magnetic field, 25:59223
ISLAM, M. M., Eikonal approximation and Mandelstam diagram, 25:59629
  Relativistic eikonal amplitude and radiative corrections, 25:59453
ISLAM, N., Measurements of the total neutron cross section of praseodymium between 1 and 18 MeV, 25:59811
ISOI, Koichiro, Study on detection methods of ^{14}C-labelled compounds, 25:57752
ITAHASHI, Takahisa, Lifetime measurements of excited states in ^{19}Ne and ^{23}Mg, 25:59719
ITO, Akihiro, Effect of partial marrow shielding on hematopoietic recovery in heavily irradiated mice, 25:58124
ITO, Mutsumi, Design of safety valves and the like for BWR-type power stations, 25:57637
ITO, Takaaki, Effect of partial marrow shielding on hematopoietic recovery in heavily irradiated mice, 25:58124
ITOH, Satoshi, Microwave interferometric measurements in medium-beta torus (JFT-2), 25:58979 (JAERI-Memo-4530)
IVANCHENKO, V. G., Variation in solubility of Ce, Pr, and Nd in Cr with temperature, 25:58237
IVANENKO, V. M., Study of large-area, flat scintillation detectors, 25:57828
IVANOV, A. P., Milling of high-temperature Nb alloy, 25:58198
IVANOV, B., Use of chromosome analysis for biological dosimetry in connection with an accident involving ^{226}Ra, 25:58016
IVANOV, B. I., Application to plasma diagnostics of the Doppler effect at the cyclotron frequency, 25:58997
IVANOV, D. N., Uranium in granite in the Gul'shad Region, Central Kazakhstan, 25:57583
IVANOV, K. G., Solar wind parameter variation, magnetic activity, and electrons of the tail of magnetosphere and radiation zone, 25:58852 (LA-tr-71-69)
IVANOV, L. I., Influence of crystal lattice defects on high-energy proton shadow effect, 25:58275
IVANOV, M., Classification and mass formulas for mesons in ladder U(6,6) symmetry, 25:59546
IVANOV, O. S., Radio intensity of Virgo A in 10 to 30-cm range, 25:58525
IVANOV, V. I., Ionization chambers with a liquid dielectric, 25:57778
  Physical characteristics of direct-charge detectors, 25:57777
  Some new developments in dosimetric detectors, 25:57846
IVANOVA, L. A., Extraction of protactinium and its analogs from solutions of oxalic and tartaric acids with tributylamine, 25:57546
IVASHCHENKO, R. K., Effect of the deformation temperature on the structure and mechanical properties of low-alloyed molybdenum, 25:58231
IWAKOSHI, Yonesuke, Operating experience of Tsuruga power station, 25:60191
IWAKURA, Tomikazu, Lactate dehydrogenase activity in cervical cancer, 25:57937
IWATA, Siro, Conference on nuclei with short life, Kumatori, Osaka, Japan, 6/30--7/1/69, 25:59834 (KURRI-TR-76)
IWATA, Yukio, Earthquake response analysis of nuclear power plant, 25:57598
IWIG, J., Some practical considerations on pancreatic scanning, 25:58061
IYER, R. M., /sup 80m/Br/I.T./^{80}Br reactions in inorganic bromide--hydrocarbon systems. I, 25:57494
IYER, Shrinivas S., Theoretical nuclear analysis of MH-1A: Cores 2 and 3, 25:60203 (AD-721019)

XUM

J

JABS, Arthur, Lorentz-invariant and non-invariant momentum space and thermodynamics, 25:59432
JACKSON, A. D., Explanation for the 0^+ excited pairing state in actinide nuclei, 25:59809
JACKSON, George Oliver, Improvements in or relating to nuclear reactor fuel elements, 25:60250
JACKSON, J. D., Evidence on duality and exchange degeneracy from finite-energy sum rules, 25:59501
  Remarks on pion photoproduction, 25:59362
JACOBY, W. R., Examination of the microstructures of mixed uranium--plutonium dioxide fuel pellets for fast flux irradiation studies, 25:58397
JACQUINOT, J., Electrostatic instabilities in a two-component anisotropic plasma, 25:59061 (CEA-CONF-1828)
JAEGER, Klaus Bruno, Quasi-two body production involving Y_1^* resonant states in K^- meson--proton interactions at 3.9, 4.6, and 5.9 GeV/c, 25:59284
JAENTSCH, O., Small rod-shaped silicon detectors for medical applications, 25:57808
  Spectral noise intensity of silicon detectors, 25:57742
JAFFEE, Max, Analysis of radiopharmaceuticals, 25:57350
JAHN, Herbert, Influence of spatial dispersion on emission of cyclotron radiation in nonequilibrium plasma, 25:59097
JAIN, C. L., Electrostatic plasma instabilities in the equatorial electrojet, 25:58900
JAKIMIEC, Jerzy, Physics of sunspots. IV, 25:58584
JAKLEVIC, J. M., Detection of low energy x rays with Si(Li) detectors, 25:57816
JAKUB, M. T., Translating elevated temperature material properties into rules for structural design, 25:60115 (HEDL-SA-164)
JAMIL, M., Acidic organodiphosphorus extractants. V, 25:57544
JANICZEK, J., Radiographical control of thickwalled welds and castings by using of betatron, 25:57678 (INR-1204)
JANIKOWSKI, Andrzej, Intercomparison measurements of SKODA and INR calorimeters on EWA-10 reactor, 25:57875 (INR-1319)
JAQUE, F., Effects of prior electrolysis on F-center growth in irradiated NaCl, 25:59164
JAROSS, R. A., Development of an in-core permanent-magnet probe-type sodium flowsensor for operation in the Fast Flux Test Facility (FFTF), 25:60183
JAROSS, Robert A., Eddy-current probe-type sodium flowsensor for FFTF reactor fuel channel flow monitoring, 25:60184
JARRETT, J. H., Thin film radiation sources by radiofrequency sputtering, 25:57651 (CONF-711002-, pp 147-59)
JARRETT, W. H., Eye tumor identification tests using semiconductor detectors, 25:58064
  Medical problems in eye tumor identification, 25:58063
JARRIEL, J. L., Static and pulsed reactivity measurements on large ^{235}U fuel forms in water, 25:60212
JASINSKI, W. K., Double-detector scinticamera for visualization of cold nodules in bulky organs, 25:57763
JASKOLA, M., Reactions (n,α) on heavy nuclei induced by 14.2-MeV neutrons, 25:59802
JASPERT, Jurgen, Radiation dosimeter having sensitive material containing lithium hydride, 25:57831
JASSBY, K. M., Dislocation mobility in copper and zinc at 44°K, 25:60265 (CALT-767-P-3-16)
  Experimental determination of the line energy of a basal screw dislocation in zinc, 25:60266 (CALT-767-P-3-17)
  Measurement of dislocation damping forces at high dislocation velocity, 25:60264 (CALT-767-P-3-15)
JEFFERY, Robert F., Scintillation scanning of liver cell adenoma, 25:58046
JEFFRIES, D. D., Technique for hot cell autoradiography, 25:57693
JEHN, H., Nitrogen solubility in metals of high melting points, 25:58249
JELINEK, F. J., Low-temperature magnetic behavior of several oxides of gadolinium, 25:59198
JELLISON, F. A., Recent advances in gas-discharge duplexers, 25:57902
JENKINS, R. T., Probabilistic model for estimating the operating cost of an electric power generating system, 25:60280 (ORNL-TM-3549)
JENSEN, A. S., Dependence of Hartree--Fock solutions in sd-shell nuclei on spin-dependent forces, 25:59878
JEONG, M. U., Annealing behavior of bulk n-GaAs irradiated by electrons, 25:59156
JEREMIE, H., Breakup of ^{9}Be, 25:59735
JESSE, William P., Ionization measurements in mercury vapor with beta particles and the mean energy to form an ion pair, 25:59123
JEW, N. N., K^-d elastic scattering and $K^-d \to K^-pn$ between 810 and 1110 MeV/c, 25:59302
JIRACEK, V., Radiation biochemistry in plants. II, 25:57931
  Radiation biochemistry in plants. I, 25:57941
JIROUSEK, V., Intercomparison measurements of SKODA and INR calorimeters on EWA-10 reactor, 25:57875 (INR-1319)
JOHANSON, M., Application of neutron activation analysis for the determination of trace amounts of bromine in pulp, 25:57383
JOHANSSON, R., Hot isostatic pressing, 25:58197
JOHANSSON, Sveneric, Resonance lines of La III, 25:58707
JOHNS, K. A., Ensemble versus time average probabilities in relativistic statistical mechanics, 25:59238
JOHNS, M. W., Energy levels in ^{191}Ir, 25:59805
JOHNS, T. F., Development of thermoluminescence dosimetry systems, 25:57840
JOHNSON, A. W., Sensitivity of nuclear emulsion at very low temperature, 25:57829
JOHNSON, A. Wayne, Electronic recombination coefficient of molecular helium ions, 25:58714
JOHNSON, C. E., Feasibility study of the identification of fuel-cladding failures using sodium-soluble isotopic tags, 25:60083 (ANL-7785)
JOHNSON, D. W., Metallographic analysis of carbide structures in cast heat-resistant alloys, 25:58399
JOHNSON, Donald R., Rotational constants for HCN and DCN, 25:57423
JOHNSON, Francis S., Lunar atmosphere, 25:58679
JOHNSON, K. A., Automated camera for hot cell metallography, 25:57627
  Chemical etchant for $(PuTh)O_2$ ceramic microscopy, 25:58354
  Proceedings of the third annual technical meeting of the International Metallographic Society, Inc., Cleveland, Ohio, November 16--18, 1970, 25:58396
JOHNSON, Ralph T. Jr., Method and apparatus for measuring fast neutron fluences with cadmium sulfide or cadmium selenide, 25:57758
JOHNSSON, Erik Borje, Pre-stressed concrete pressure vessel, 25:60069
JOLLY, R. K., Determination of trace elements in samples by nuclear scattering and reaction techniques, 25:57360
JONA-LASINIO, G., Explicit examples of off-diagonal long-range order, 25:58918
JONES, A. R., Gamma monitor for measuring environmental gamma doses and dose rates, 25:57721 (AECL-3989)
JONES, A. V., Exact propagator, 25:59349
JONES, D. H. P., Red RR Lyrae variable DK Velorum, 25:58453
JONES, Frank C., Dynamic equation for stochastic magnetic field lines in Galaxy, 25:58657
  Suprathermal proton bremsstrahlung by Weizsaecker--Williams method, 25:58837
JONES, G. H., Design for access and inspection in gas-cooled reactors, 25:60026
JONES, G. K., Cost benefit analysis of the choice between nuclear and other fuels, 25:59921
JONES, R. B., Uniformization in a soluble partial wave model, 25:59620
JONES, R. K., Effects of airblast on sheep in two-man foxholes, 25:60272 (DASA-2711)
JONES, Robert W., Factorization and folded diagrams in Goldstone linked-cluster series, 25:59865
JONES IV, Lewis Hammond, Search for decay of short-lived neutral K meson into two charged pi mesons and one neutral pi meson, 25:59259
JONGEJAN, A., Liquidus determinations in pseudo-ternary sub-system $CaO.Nb_2O_5$--$CaO.TiO_2$--SiO_2, 25:58390
JONKE, A. A., Chemical Engineering Division fuel cycle technology quarterly report, January--March 1971, 25:57507 (ANL-7799)
JORDAN, Walter H., Nuclear power: social needs and benefits, 25:60002
JOSEPH, J., Reconstruction of amplitudes for pion--nucleon scattering from experimental data, 25:59498
JOSEPH, P. M., Branching ratio for decay of phi mesons into lepton pairs, 25:59310
JOSHI, G. C., Dependence of molecular dissociation equilibrium on magnetic field strength in sunspots, 25:58589
JOSHI, P. C., Binding energies of alpha-particle nuclei, 25:59725
JOSIAS, Conrad S., Instrument for the measurement of auroral electrons and protons, 25:57790
JOSSELSON, R., Stability of reactor control systems in coupled core reactors, 25:60051
JOSTSONS, A., Effects of structural imperfections on voids in aluminum, 25:58298 (ORNL-TM-3493)
JOY, D. S., Probabilistic model for estimating the operating cost of an electric power generating system, 25:60280 (ORNL-TM-3549)
JOYCE, Glenn, Numerical integration methods of Vlasov equation, 25:59040
JOYEUX, J., High-temperature neutron dosimeters, 25:57723 (CONF-711002-, pp 82-5)
  Sample preparation by metallurgical methods, 25:58179 (CONF-711002-, pp 47-58)
JUBB, Albert, Power plants, 25:60141
JUCKER, C., Clinical and technical observations in therapy with 42 MeV betatron, 25:58076
JUCYS, A. P., Use of reflection symmetry in atomic theory, 25:58784
JUDD, B. R., Second use for the group G_2, 25:58785
JUDISCH, J. M., Study of the reticuloendothelial system in hematological diseases, 25:58053
JUN, Moo Jin, F-aggregate centers in Na chloride. I, 25:59152
JUNG, Peter, Determination of the anisotropy of the threshold energy for the production of Frenkel defects

XUM

in Ta, 25:59125 (JUL-729-FF)
JUNKER, D., Neutron dosimetry with radiation elements, 25:57776
JURA, M., He$^+$/H$^+$ concentration ratios in H I regions, 25:58630

K

KABACHNIK, N. M., Unified description of inelastic and quasielastic electron scattering from nuclei, 25:59869
KABIR, P. K., Nuclear reactions initiated by recoil nuclei, 25:59814
KACZAROWSKI, R., Decay scheme of ^{232}Pa, 25:59798
KADAR, Imre, Theoretical and experimental results on internal bremsstrahlung accompanying electron capture, 25:59885
KAESTNER, F., New virtual and analogue states in ^{47}V, 25:59752
KAGAN, A. Robert, Comments on morbidity in present-day radiotherapy, 25:58077
KAGANOVICH, D. I., Milling of a specimen surface hardened by a Cr--W wire, 25:58196
KAGAWA, Tatsuo, Thermal and hydrodynamic transfer functions of BWR core, 25:60038
KAHN, Daniel R., Jet-mixed liquid--liquid extraction column, 25:57623
KAHN, J. S., Analysis of Jorum containment, 25:57607
KAIDALOV, A. B., π^-p interactions at 3.25 GeV/c, 25:59314
KAISER, Robert Hamilton, Capillary-reservoir diffusion studies in Hg--In alloys utilizing continuous resistivity measurement of composition, 25:58210 (IS-T-490)
KAISER, W. C., Improved light output from very thin plastic scintillator, 25:57819
KAJANTIE, K., Dual + Pomeron analysis of $K^{+-}p \to K^{+-}\pi^0p$, 25:59490
KAJFOSZ, J., Linear polarization of low-energy capture γ-rays from ^{35}Cl(n,γ) reaction, 25:59745
KAJNAK, K., Evaluation of effective operators for configuration interaction, 25:58798
KAKEHI, Masae, Residual lesions following external high energy radiation therapy, 25:58074
KAKU, M., Functional approach to dual quark models, 25:59435
KAKUTANI, Tsunehiko, Weak nonlinear magneto-acoustic waves in an inhomogeneous plasma, 25:59086
KALASHNIKOV, N. P., Distribution of energy losses for heavy positive particles in a single crystal, 25:59150
KALETTA, D., Atomic interaction potential for nickel, 25:59145
KAL'KHMAN, L. E., Approximation method of calculation of the boundary layer of dual-temperature plasmas on electrodes at higher values of the Hall parameter, 25:59051
KALININ, G. P., Superconducting alloys of Nb--Al--Ge system, 25:58948
KALISKI, S., Averaged equations of laser heating of D--T plasma, 25:58965
KAL'KIS, V. Ya., Efficiency of some antioxidants in the thermooxidative degradation of irradiated polyethylene, 25:57462
 Thermostabilization of irradiated filled polyethylene, 25:57446
KALKOFEN, W., Line formation in pulsating variable stars, 25:58543
KALLIO, A., Comparison of Brueckner and Jastrow methods in electron scattering, 25:59704
KALMUS, G. E., K^-d elastic scattering and $K^-d \to K^-pn$ between 810 and 1110 MeV/c, 25:59302
 π^+p elastic scattering data between 1820- and 2090-MeV cm energy, 25:59309
 Reaction $\pi^+ p \to \Sigma^+ K^+$ at 1.28 and 1.41 GeV/c and a test of charge independence, 25:59311
KALMYKOVA, I. S., Successive determination of uranium and thorium in oxides of the rare earth elements, 25:57341
KAL'NENKO, B. I., Effect of heating by glow discharge on the physico-chemical surface condition of solid alloys, 25:58233
KAMADA, Toru, Heterotopic bone formation in the lung, 25:58133
KAMAKAZU, Kiyomaro, Radiosensitivity of the radiation induced aminopterin resistant yeast cells, 25:57927
KAMAT, G. R., Open aluminothermic reduction of columbium (Nb) pentoxide and purification of the reduced metal, 25:58202
KAMENETSKII, A. B., Comparison of two methods for testing the abrasive resistance of refractories, 25:58386
KAMISAKO, M., Leak rate test on reactor containment vessel for Mihama Power Station, 25:60000
KANAPILLY, G. M., Separation of multicurie quantities of ^{90}Y from ^{90}Sr, 25:57352
KANASAKI, Yoshiki, Local circulation in irradiated skin, 25:58125
KANCHELI, O. V., Inclusive processes at large transferred momenta, 25:59444
KANDO, Masashi, High density theta-pinch plasma pre-ionized by shock wave, 25:59056
KANE, G., Energy spectrum of ^{6}Li fragments resulting from bombardment of AgBr by 28 GeV protons, 25:59278
KANE, R. P., Characteristics of storm-time geomagnetic daily variation, 25:58874
KANEDA, A., Leak rate test on reactor containment vessel for Mihama Power Station, 25:60000
KANEKO, Shobu, Viscosity coefficients of a plasma in a strong magnetic field, 25:59029
KANEVSKII, Yu. P., Cosmogenic ^{22}Na in surface waters of dry land, 25:57568
KANTARIZIS, E., Measurement of thickness of a sporadic-E layer, 25:58881
KANZAWA, Hiroshi, Performance of clinical linear accelerator, 25:59661
KAPAHI, V. K., Lunar occultation observations of 25 radio sources, 25:58538
KAPLAN, Joan C., Enzymatic repair of deoxyribonucleic acid. IV. Mechanism of photoproduct excision, 25:57928
 Enzymatic repair of DNA. III. Properties of the UV-endonuclease and UV-exonuclease, 25:57935
KAPLAN, N., ^{153}Eu indirect spin--spin interaction, 25:59200
KAPLAN, S. A., Possible antenna mechanism for cosmic radio emission, 25:58526
KAPLAN, S. I., HTGR safety, 25:60130
KAPLINA, G. S., Surface nitriding of zirconium, 25:58173
KAPUSTNIKOV, A. A., Effective Lagrangian of nonleptonic weak interactions and parity-nonconserving nuclear forces, 25:59418
KARABAEV, T. A., Thermoemissive properties of a spherical monocrystal of tantalum, 25:59177
KARASEV, V. S., Investigation of the calibration characteristics of a radiation thermodiverter in high-intensity fields of ionizing radiations, 25:57879
KARAULOV, A. G., Investigation of volatilization of MgO and ZrO_2 in oxidizing atmospheres, 25:58345
KARAVAEV, F. M., Preparation of gas samples from carbonates and their solutions for measurements of activity of ^{14}C, 25:57358
KARAVAEV, V. M., Protection of animals against injury by nuclear weapons, 25:58026
KARAZIYA, R. I., Theoretical calculation of energy levels for rare earth element ions, 25:58709
KARIMOV, S. N., Gamma ray-induced disorientation of polymer molecules, 25:58417
KARITANI, Yoshiaki, Mechanism of interphasic death in radiation damage, 25:58084
KARLENKO, G. S., Determination of the oxygen content in metallic ruthenium, 25:57329
KARLIVAN, V. P., Efficiency of some antioxidants in the thermooxidative degradation of irradiated polyethylene, 25:57462
 Thermostabilization of irradiated filled polyethylene, 25:57446
KARMANOV, V. A., Multibaryon resonances with $B > 5$ in model with exchange Δ--N interaction, 25:59521
KARNAKOV, B. M., Polarization properties of particles produced at high energies, 25:59328
KARPMAN, V. I., Nonlinear theory of plasma motion in a high-frequency electromagnetic field, 25:59037
KARTALEV, M. D., Stationary simple waves in a plasma at anisotropic pressure, 25:59085
KARULE, K., Evaluation of transition matrix elements for multiphoton processes in atomic hydrogen, 25:58770
KASAKOV, A. I., Plasma parameters and the population of excited atomic states in a low-current helium arc, 25:59017
KASHEVSKAYA, O. N., Variation in solubility of Ce, Pr, and Nd in Cr with temperature, 25:58237
KASHUK, V. A., Modification of cast zirconium by additions of transition metals, 25:58258
KASHUKEEV, N., Gamma-radiation-induced changes in SiC semiconductor varistors, 25:57903
KASHY, E., Isobaric mass equation in $A = 4n + 1$ nuclei, 25:59882
KASILOV, V. I., Nuclear photofission cross sections for photon energies up to 5 GeV, 25:59794
KASLINA, N. A., Rezarson as a reagent for the spectrophotometric determination of niobium, 25:57333
KASRAI, M., Chemical effects of nuclear transformations in alkali chlorides. III, 25:57503
KASTEN, Paul R., Evaluation of plutonium use in high-temperature gas-cooled reactors, 25:60097 (ORNL-TM-3525)
KASUGA, Tsutomu, Electron microscopic study of radiation effects on cultured cells with different radiosensitivities, 25:58085
KATAEV, R. S., System molybdenum--nickel--carbon, 25:58290
KATAYAMA, M., Leak rate test on reactor containment vessel for Mihama Power Station, 25:60000
KATHREN, R. L., Intercomparison of the characteristics of beta/gamma and neutron survey instruments, 25:57782
KATHURIA, S. P., Effects of residual thermoluminescence in fluorite and lithium fluoride thermoluminescent dosimeters, 25:57844
KATO, T., Observation of cosmic soft X rays, 25:58548
KATO, Toyoaki, Study of photo-nuclear reaction by means of residual nucleus method, 25:59815
KATO, Y., New thermoluminescence dosimeter of high sensitivity using a magnesium silicate phosphor, 25:57841
KATO, Yoshio, Whole-body absorbed dose from x and gamma rays, 25:58004
KATOH, Toshio, Experiment on short lived nuclei, 25:59781 (KURRI-TR-76, pp 19-20)

XUM

KATSURAGI, S., Benchmark test by various cross section sets for fast reactor analysis in Japan, 25:60210 (JAERI-Memo-4406)
KATSURAGI, Y., Recent fallout of radioactive dust in Japan, 25:57579
KATSUURA, Kanji, Temperature dependence for destruction of metastable He(2^3S) atoms, 25:58731
KATZ, Ronnie, Collision of an atom and a diatomic, 25:58761
KAUFFMANN, J., Survival of Azotobacter chroococcum following γ irradiation and ibenzmethyzine treatment, 25:58156
KAUFMAN, Leon, Self-triggered wire chambers for radiation imaging purposes, 25:57784
KAUFMAN, N. C., Summary of ETR Critical Facility safety analysis information, 25:60149 (ANCR-1002)
KAUPPILA, W. E., Lyman-alpha emission induced by the collisions of electrons with molecular hydrogen, 25:58729
KAUS, P., Complex Regge poles in πN backward scattering, 25:59495
KAVERINA, S. N., Effect of the deformation temperature on the structure and mechanical properties of low-alloyed molybdenum, 25:58231
KAWAKAMI, M., Chemically stable electrode material in liquid iron, 25:57441
KAWAMURA, Nobuaki, (γ,α) reaction experiment, 25:59734
  Isospin effect in ^{31}P(γ,n) reaction, 25:59765
KAWAMURA, T., Stochastic model of electron-cyclotron heating in a magnetic mirror, 25:58968
KAWANO, Yoshiaki, Effects of pH on /sup 113m/In distribution, 25:58043
KAWASAKI, S., Measurement of the plasma current distribution in a tokamak device with alpha-particles injected transverse or parallel to the toroidal axis, 25:58980 (JAERI-Memo-4531)
KAWASE, Akira, Effect of partial marrow shielding on hematopoietic recovery in heavily irradiated mice, 25:58124
KAZAWA, Yoshiaki, Torus device for thermonuclear fusion equipment: JFT-1, 25:59079
KEAN, D. C., Magnetic analysis of reactions ^{7}Li(^{3}He,d)^{8}Be and ^{7}Li(^{3}He,t)^{7}Be, 25:59731
  Search for high-spin states in ^{27}Al, 25:59761
KEATON, P. W. Jr., Formalism for the [polarized] T(d,n)^{4}He and ^{3}He(d,p)^{4}He reactions, 25:59837 (LA-4492)
KEBADZE, B. V., Some properties of boiling-water reactor self-oscillation conditions, 25:60037
KEENAN, Philip C., Technetium in Mira variable RZ Pegasi, 25:58459
KEFAUVER, H. L., Use of a time-shared, on-line computer to support basic and applied radiation research, 25:59666
KEGEL, Gunter H. R., Purification of germanium crystals with a lead getter, 25:57736
KEIL, E., Stochasticity in many-dimensional nonlinear oscillating systems, 25:59652
KEIL, G., Semiconductor GM counter, 25:57747
KEIL, R., Spectrophotometric determination of Ca, 25:57304
KEIZER, A. S., Branching ratio for decay of phi mesons into lepton pairs, 25:59310
KELLY, J. G., Magnetic Compton spectrometer for high intensity pulsed gamma ray environments, 25:57813
KELLY, M. D., Metallographic analysis of cermet fuel forms, 25:58398
  Quantitative analysis of a cermet sphere, 25:58388 (MLM-OP-71006)
KELLY, Robert C., Selected, annotated bibliography of the civil, industrial, and scientific uses for nuclear explosives, 25:57603 (TID-3522(Rev.9))
KENDALL, P. C., Extrusion of plasma into confined magnetic field of line dipole, 25:58859
KENESHEA, F. J., Diffusion of oxygen in zirconia as a function of oxygen pressure, 25:58370
KENNEL, C. F., Locating the magnetospheric ring current, 25:58854
KEPPEL, E., $\pi\pi$ scattering effects in π^+p interactions at 8 GeV/c, 25:59296
KERBIKOV, B. O., New type of baryon resonances, 25:59500
KERIMOV, B. K., Two-component and four-component theories of neutrino, 25:59407
KERNAN, A., π^+p elastic scattering data between 1820- and 2090-MeV cm energy, 25:59309
KESLEV, D., Use of chromosome analysis for biological dosimetry in connection with an accident involving ^{226}Ra, 25:58016
KESNER, J., Plasma confinement in the DECA II B circularized magnetic well, 25:58958 (CEA-CONF-1807)
KESSEL, Q. C., Probability for producing K vacancies in violent ion--atom collisions at keV energies, 25:58756
KESSER, G. M., Prog. rpt. on sodium technology, 1--3/71, 25:60058 (ANL-7817)
KESSLER, P., Study of vertices $\pi^0\gamma\gamma$, eta$\gamma\gamma$, and eta'$\gamma\gamma$ with almost real photons, 25:59253
  Study of vertices $\pi^0\gamma\gamma$, eta$\gamma\gamma$, and eta'$\gamma\gamma$ with one highly virtual photon, 25:59389
KESTENBAUM, H., Oscillation in optical and x-ray flux from Scorpius X-1, 25:58535
  Oscillations in x-ray flux from Scorpius X-1, 25:58536
KEY, J. R., Average energy expended per ionized electron-hole pair for α particles in Si(Li), 25:57788
KHACHATRYAN, A. G., Kinetic method for analyzing mixtures of rare earth elements, 25:57319
KHADKIKAR, S. B., Alpha clustering in light nuclei with Skyrme interaction, 25:59883
  Shape mixing in ^{24}Ne, 25:59728
KHAIDAROV, A., Determination of tantalum in sphere by activation analysis, 25:57371
KHAIMOVA, Sh. M., Elimination of the effect of the sample composition on the line intensity of certain rare metal impurities, 25:57330
KHAKIMOV, P. A., Effect of ionizing radiation on mitotic activity of cultured cells, 25:58080
KHALILOV, V. R., Radiation of scalar particles in field of two traveling electromagnetic waves moving toward each other, 25:59226
KHAMIDOV, D. Kh., Effect of ionizing radiation on mitotic activity of cultured cells, 25:58080
KHAMIDULLIN, M. G., Critical field of a solid cylinder with a coating of normal metal, 25:58941
KHAN, A. H., Radiosensitivity studies in sunflower, 25:58148
KHAN, H. A., Ivory Coast microtektites, 25:57565
KHANDELWAL, G. D., Platinum--graphite electrode system for the biamperometric determination of iodine, 25:57302
KHARIN, V. P., Bremsstrahlung yield as function of target thickness and atomic number in electron energy range 12 to 22 MeV, 25:59106
KHASAN, M. A., System for automatic startup and power regulation of research reactors, 25:60169
KHASANOV, A. S., Radioactivation determination of Se, Te, and Au in natural waters, 25:57370
KHAUTIEV, E. Yu., Plasma losses in high-current plasma configurations due to the inverse skin effects, 25:58967
KHERRMANN, I., Compton effect and induced Compton effect in constant electromagnetic field, 25:59368
KHETEEV, M. V., Investigation of buildup region for γ-radiation from low-level sources, 25:59120
KHIL, Sh. V., Influence of high-frequency potential of a toroidal electric field on the trapping of charged particles in a closed magnetic trap, 25:58975
KHIZNICHENKO, L. P., Effects of heat treatment and γ irradiation on photodeformation effect in Ge, 25:59128
KHMELININ, B. A., Temperature measurement of heavy particles in a plasma in a magnetic field, 25:58988
KHODEEV, Yu. S., Mass spectrum of zirconium borohydride, 25:58377
KHODEL, V. A., Method of calculating low-lying spectra in spherical nuclei, 25:59884
KHOKHLOV, M. Z., Velocity and temperature of solar wind, 25:58613
KHOKHLOVA, Z. S., Nonrelativistic particles produced in interactions of multicharged cosmic ray nuclei with light nuclei of emulsion, 25:59274
KHOLODOV, A. G., Variation in solubility of Ce, Pr, and Nd in Cr with temperature, 25:58237
KHOLOPOV, P. N., Density distribution of bright stars in the globular cluster M56, 25:58429
KHOLSHCHEVNIKOVA, E. K., Distribution discontinuities of electric currents and fields in flows with thin layers of highly conducting gas, 25:58850
KHOZE, V. A., Possibility of observing quasinuclear meson resonances in colliding e^+e^- beams, 25:59358
KHRAMOV, N. N., Activation detector, 25:57729
KHRISTOV, V., Note on the determination of neutron diffusion constants, 25:59687
KHROMOV, V. V., Optimization study of fast reactors, 25:60217
KHROMOV, Yu. V., New radiometric apparatus for prospecting radioactive ores, 25:57867
KHRYPCHANKA, I. P., Radiation-induced change of enzyme activity during blocking of the adrenal cortex, 25:57929
KHUDAIBERGENOV, U., Radioactivation determination of Se, Te, and Au in natural waters, 25:57370
KHUTORYANSKII, E. D., Effects of composition of hardfacing alloys on their hardness, 25:58235
KIDDER, R. E., Use of long-wavelength, high powered lasers for controlled thermonuclear fusion, 25:59054 (MATT-782)
KIEFFER, Arthur W., Analytic study of an electric stepping motor drive for a nuclear reactor control drum, 25:60193 (N-71-26979)
KIEFHABER, E., Check of nuclear data and methods of calculation by integral experiments, 25:60036 (EURFNR-945)
KIELSZNIA, R., Radiographical control of thickwalled welds and castings by using of betatron, 25:57678 (INR-1204)
KIENLE, P., Measurements of NMR on oriented ^{192}Ir and /sup 191m/Ir in Ni and Fe host lattices, 25:59807
KIGA, Masami, Radiosensitivity of the radiation induced aminopterin resistant yeast cells, 25:57927
KIKNADZE, G. I., Experimental studies of power increase in In--Ga radiation loops, 25:60170
KILAPARTI, S. R., Combined helium and steam cycle for nuclear power plants, 25:60139
KIM, Bjong-Ro., Selection rules in the weak interactions and their relation to hadronic mesons, 25:59393
KIM, J. I., Calculations for production of ^{231}Pa and ^{232}U by neutron irradiation from ^{230}Th and ^{232}Th mixtures in the reactor with various irradiation conditions, 25:57479 (BMBW-FBK-71-6)
KIMEL, L. R., Activation of concrete shield of OIYaI

XUM

synchrocyclotron, 25:59657
KIMMEL, Hermann, Radiation detector with gas-permeable radiation window, 25:57756
KIMPARA, Atsushi, Correlations between sudden phase anomalies in very long waves and bursts of solar x rays, 25:58888
KIMURA, Mitsuo, Radiation therapy in cancer of the uterine cervix, 25:58070
KIMURA, Motoharu, Study of nuclei by electron scattering, 25:59736
KIMURA, Y., Dual structure of anti KN scattering in intermediate energy region, 25:59504
KINDL, P., Reactor kinetic calibration of neutron sources and its comparison with bath methods, 25:59688
KING, H. J., Mercury electron-bombardment ion thrusters, 25:59011
KING, Ivan R., Stellar populations in galaxies, 25:58636
KING, J. W., Semiannual variation in height of F2-layer peak, 25:58879
KING, Kenneth W., Earthquakes on and around Nevada Test Site, 1950--71, 25:57589 (CGS-746-12)
KING, L. J., Summary of the campaign during February 1969 to process six irradiated HFIR targets in the transuranium processing plant, 25:57524 (ORNL-TM-3343)
KING, Paul H., Multicrystal tomographic scanner for mapping thin cross section of radioactivity in an organ of the human body, 25:57754
KING, Paul N., Uptake of ^{125}I labeled rat gamma globulin by intestinal epithelial cells in the neonatal rat, 25:60278 (NYO-3515-6)
KING, R. T., Effects of structural imperfections on voids in aluminum, 25:58298 (ORNL-TM-3493)
  Failure of aluminum tubing in the ORNL 86-inch cyclotron, 25:59643 (ORNL-TM-3523)
KINNEBROCK, W., Strategies for accelerating two-dimensional SN methods by coarse lattice technique, 25:60224 (EURFNR-899)
KINSEY, James L., Velocity corrections for total scattering cross sections, 25:58757
KIPARISOV, S. S., Effect of nitriding on the properties of tantalum, 25:58259
KIRILLOV, V. S., Study of the gas evolution and mechanical properties of molybdenum wire, 25:58221
KIRILLOV-UGRYUMOV, V. G., Production of $\pi^+2\pi^-$ on nuclei at small momentum transfers, 25:59316
KIRIN, B. M., Mass spectrum of zirconium borohydride, 25:58377
KIRK, J., DFR primary circuit failure, 25:60078
KIRSCH, H., Morphology and chemistry of magnetite layers, 25:58165 (AEC-tr-7237)
KIRSTEN, Frederick A., Operational characteristics of the CAMAC dataway, 25:57882
  Short description of the CAMAC branch highway, 25:57881
  Some characteristics of interfaces between CAMAC and small computers, 25:57885
KIRYUTIN, A. K., Thermal conductivity of ceramics based on boron nitride and aluminum nitride, 25:58385
KIRZHNITS, D. A., High-temperature superconductivity, 25:58934
KISELEV, O. A., Transformer for accelerator tube, 25:59648
KISHORE, K., Thermal annealing and solid state isotope exchange of ^{51}Cr in K trisoxalato chromate(III) trihydrate, 25:57490
KISLYAKOV, A. G., Radio intensity variations of 3C 273 at 2.3 and 8.15 mm, 25:58524
KISSINGER, H. E., Microstructural analysis of neutron-irradiated titanium and rhenium, 25:58302
KISSLINGER, Leonard S., Dispersion relations for nuclear structure physics, 25:59691 (LA-DC-12958)
KISTENEV, Z. P., Structure of scattering amplitudes and inelastic process amplitudes in pre-asymptotic region, 25:59497
KITAGAWA, Mitsuo, Abnormal stopping power of proton and ion channeling, 25:59129
KITAGAWA, Toshio, Residual lesions following external high energy radiation therapy, 25:58074
KITAHARA, Takashi, Radiosensitivity of the radiation induced aminopterin resistant yeast cells, 25:57927
KITANI, K., Axial vector form factor of the nucleon and the quark--parton model, 25:59391
KITANO, Yasushi, Coprecipitation of uranium with calcium carbonate, 25:57409
KITS, J., Absolute activity measurement of ^{3}H, 25:57505
KIURU, A., ^{27}Al(p,γ)^{28}Si resonances, 25:59762
  Energy determinations of gamma rays and new weak transitions in decay of ^{56}Co, 25:59763
  Nuclear levels and transitions in odd Cu isotopes. II, 25:59764
KIYOSE, Ryohei, Application of linear programming to refueling optimization for light water moderated power reactors, 25:60104
  Conceptual design of the reactant flow loop for fissiochemical studies, 25:57613 (JAERI-Memo-4446)
KJAERGAARD, P., Determination of atmospheric parameters for G and K giants, 25:58481
KLAISNER, L. A., Accelerator instrumentation and control system using CAMAC, 25:59664
  NAL CAMAC accelerator control, 25:59655
KLAPDOR, H. V., New virtual and analogue states in ^{47}V, 25:59752
KLASSEN, N. V., Optical measurements on solvated electrons in pulse-irradiated liquid propane, 25:57468
KLEIN, Edmund, Tumors of skin. XII, 25:58037
KLEINER, C. T., Modification of the TRAC Ebers--Moll model for improved high frequency and collector storage time predictions, 25:57904
KLEMA, E. D., High-resolution 5000μ silicon surface-barrier detectors, 25:57801
KLESHCHENKO, E. D., Ionization chambers with a liquid dielectric, 25:57778
KLIMA, R., High-frequency heating in Tokamaks, 25:58966
KLIMCHITSKAYA, G. L., Ground state energy of two-electron atoms with arbitrary nuclear charges Z less than or equal to 137, 25:58818
KLIMENT, Vladimir, Continuous neutron activation analysis, 25:57388
KLIMENTOV, V. B., Microdistribution of fission density in VVR-M, 25:60172
KLINE, Laurence Earl, Computer simulation of electrical breakdown in gases, 25:59004
KLOTZ, Frederick S., Study of general relativity in canonical form, 25:59592
KLYNCZAK, Joanna Alina, Influence of uv radiation on pigeon erythrocytes, 25:58113
KLYUCHAREV, A. P., Gamma-activation method for determining carbon and oxygen in beryllium, 25:57385
KNECHT, O., Reliability requirements for nuclear power plants, 25:60122
KNIGHT, D. W., Summary of ETR Critical Facility safety analysis information, 25:60149 (ANCR-1002)
KNIGHT, R. W., Development of manufacturing procedures for HFIR fuel plates to ORNL specification, 25:58349 (ORNL-4713)
KNIGHTON, J. B., Development of a mixer-settler for liquid metal-salt systems, 25:57508 (ANL-7810)
KNOCKAERT, A., Saint-Laurent I fuel melt down incident, 17 Oct 1969, 25:59924
KNOERR, B. K., Uranium industry with realistic concepts of consumption, 25:58191
KNORR, D., Processing data in nuclear medicine with the aid of desk-top computers, 25:58065
KNORR, Georg, Numerical integration methods of Vlasov equation, 25:59040
KNOTIK, K., Reprocessing of oxidic thorium-containing nuclear fuel particles with chlorine gas, 25:57542
KNUDSEN, Per, Preparation of isotope targets by heavy-ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
KNYAZEV, V. K., Radiation stability of lacquer coatings, 25:58420
KNYAZEV, Yu. V., Optical properties of Gd, Sm, and Dy in spectral range 1.13 to 3.96 eV, 25:59187
KNYAZEVA, I. M., Study of the composition of oxide coatings using radioisotopes, 25:57660
KOBAYASHI, Shigeo, Stability study of a PWR nuclear power station connected to an electric power system, 25:60105
KOBAYASHI, T., Differences between reactions of gaseous CH_3Br with ^{80}Br and ^{82}Br, 25:57492
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KOBAYASHI, Tetsuji, Radiation detector for insertion into a blood vessel, 25:57760
KOBISK, E. H., Preparation of self-supporting, metallic foils of isotopic chromium, 25:59633 (CONF-711002-, pp 39-46)
KOBRINSKII, M. N., Structure of scattering amplitudes and inelastic process amplitudes in pre-asymptotic region, 25:59497
KOBYLKIN, A. F., Automatic ultrasonic installation for decontamination of footwear on human legs, 25:57629
KOBZENKO, G. F., Variation in solubility of Ce, Pr, and Nd in Cr with temperature, 25:58237
KOCH, L., X- and γ-ray astronomy and TD-1, HEOS-B, and COS-B sattellite mission, 25:58829
  X- and γ-ray astronomy between 1962 and 1970, 25:58533
KOCH, W., Reaction $\pi^-p \to K^+K^-n$ between 988 and 1100 MeV invariant KK mass, 25:59301
KOCHNOV, V. A., Induced reactions in radiochemistry. VI, 25:57413
KODATSKII, S. B., Constructional features of nuclear-powered vessels, 25:60204
KODIRI, S., Neutron activation analysis of enriched isotopes of Eu, In, Ir, and Lu, 25:57391
KOEBKE, K., Thermodynamics of hyperon stars, 25:58521
KOEHLER, J. S., Low-temperature annealing of electron-irradiated germanium, 25:59132
KOELBL, F., Preferred position of tungsten carbide in th composition of hard metals, 25:58261
KOENIG, D. R., Slow-neutron cross-sections of fissile nuclei, 25:59879
KOENIG, V., Vector and tensor analysing powers of the D(d,p)T and D(d,n)^{3}He reactions at 10.0 and 11.5 MeV, 25:59700
KOESTER, L., Neutron--proton and neutron--carbon scattering amplitudes, 25:59696
KOGAN, I. A., Effect of ACTH on sympathico-adrenal system in dealing with radiation sources, 25:57938
KOGER, J. W., Mass transfer between Hastelloy N and Haynes alloy No. 25 in a molten sodium fluoroborate mixture, 25:58169 (ORNL-TM-3488)
KOHARA, Yoji, Nonleptonic decays of neutral K mesons and Lee--Sugawara sum rule, 25:59396
KOHL, H., Semiannual variation in height of F2-layer peak,

XUM

25:58879
KOHLER, J., Radiation induced ionic polymerization, 25:57450 (ORO-3667-1)
KOHMURA, Toshitake, Pion--nucleus scattering from 120 MeV to 1200 MeV, 25:59712
KOIRTYOHANN, S. R., Atomic absorption spectrophotometric determination of molybdenum in fertilizers, 25:57306
KOJIMA, Yuzo, Study of nuclei by electron scattering, 25:59736
KOKORIN, V. V., Structure of decomposed Co--Nb alloy, 25:58280
KOKSHAROVA, S. F., Energy tables for gamma ray emission during radioactive decay, 25:59785
KOKTA, L., Absolute activity measurement of ^{3}H, 25:57505
KOLAR, D., Phase equilibria in system BaO--CeO$_2$, 25:58405
KOLAR, J., Irradiation sequelae in the heart and major vessels, 25:58147
KOLC, Jiri, Process of manufacturing radioactive substances derived from difluoresceny lmercury and labelled with radioactive iodine isotopes, 25:58047
KOL'CHUZHKIN, A. M., Defect detection in gamma-scintillation nondestructive testing, 25:57701
KOLESNIKOVA, S. S., Effect of ionizing radiation on mitotic activity of cultured cells, 25:58080
KOLIKOVA, G. P., Mechanical properties of molybdenum-base alloys, 25:58248
KOLINSKA, J., Fast preparation method of ^{32}P applicators, 25:57500
KOLOKOL'TSOV, N. A., Study of effective nonsymmetric multicomponent isotope separation cascades, 25:57670
KOLYAKOV, V. L., Protection of animals against injury by nuclear weapons, 25:58026
KOMAR, A. P., Bremsstrahlung from 7- to 10-MeV electrons in thin Si crystals, 25:59149
KOMAREVSKII, S. K., Nonisothermal superconducting bolometer. II, 25:58952
KOMAROVA, Yu. P., Optimal time of using a radioisotope source of radiation in nondestructive testing, 25:57697
KOMBERG, B. V., Are quasi-stellar objects the nuclei of embryonic galaxies, 25:58626
KOMESAROFF, M. M., Interstellar scattering and low-frequency spectrum of PSR 0833-45, 25:58540
KOMISSAROVA, L. N., New phases in Sc--V--O system, 25:58401
KOMORI, Takuji, Chemical analysis of the fuel solution of JRR-1, 25:57320
KOMPANEETS, D. A., Surface second sound in liquid helium, 25:58931
KOMURA, K., Production of ^{26}Al and ^{22}Na, 25:59753
KOMURA, Kazuhisa, Absolute measurement of alpha ray by a surface-barrier type silicon detector, 25:57794 (INS-TCH-5)
KOMYAK, A. I., Symmetry of excited electronic states in uranyl nitrate crystals, 25:58703
KONDO, K., Differences between reactions of gaseous CH$_4$ with ^{80}Br and ^{82}Br, 25:57491
Differences between reactions of gaseous CH$_3$Br with ^{80}Br and ^{82}Br, 25:57492
KONDRAT'EV, V. I., Hydrodynamic problems of vessel-type boiling-water reactors, 25:60065
KONDRAT'EV, Yu. S., Influence of 5-bromouracil on sensitivity of Her^{+}- and Her^{-}-bacteria to lethal and mutagenic effect of uv-light, 25:57965
KONIG, Edward, Extension of Chou--Yang model to include spin, 25:59513
KONOPLEVA, R. F., Formation and annealing of radiation defects in Ge, 25:59159
KONOVODCHENKO, V. A., Nonisothermal superconducting bolometer. II, 25:58952
KONSTANTINOV, B. P., Investigation of γ radiation by Cosmos-135, 25:58835
Investigation of variations of annihilation γ radiation by Cosmos-135, 25:58836
KONSTANTINOV, I. E., Comparison and analysis of the parameters of clinical whole-body spectrometers, 25:57823
KONSTANTINOVICH, A. A., Deactivation of radioactive sewage by the method of two-step coagulation of ferric hydroxide, 25:57556
KOONTZ, R. L., Analysis of aerosol behavior for FFTF hypothetical accidents, 25:60148 (AI-69-Memo-95)
KOPAL, Zdenek, Nonlinear effects of limb darkening in eclipsing variables, 25:58490
KOPCHINSKII, G. A., Microdistribution of fission density in VVR-M, 25:60172
KOPECKY, M., Relation between electric conductivity in faculae and in Bilderberg model of photosphere, 25:58588
KOPECKY, V., Mechanical properties of Mo and W single crystals, 25:58257
KOPSKY, V., Molecular field study of isotopic effect in KH/sub 2x/D/sub 2(1-x)/PO$_4$ mixed crystals, 25:59196
KORENCHENKO, S. M., Search for $\pi^{+} \to e^{+} + \nu$/sub e/ + $e^{+} + e^{-}$ decay, 25:59255 (BNL-tr-451)
Search for the decay $\mu^{+} \to e^{+} + e^{+} + e^{-}$, 25:59254 (BNL-tr-449)
KORENNAYA, L. N., Diffraction polarization of neutrons in a polarized crystal, 25:59681
KORFHAGE, Robert R., Bounds on the bandwidth of bipartite graphs, 25:60274 (LA-4744)
KORKEA-AHO, M., Isospin invariance and πN backward scattering, 25:59287
KORMENDY, John, Structure of rapidly rotating relaxed globular clusters, 25:58494
KORNILOV, I. I., Oxidation of niobium containing oxygen, 25:58172
KORNMANN, Michel, Measurement of parameters of Ce plasma, 25:58986
KOROBOCHKO, Yu. S., Bremsstrahlung from 7- to 10-MeV electrons in thin Si crystals, 25:59149
KORODENKO, G. D., Gamma ray-induced disorientation of polymer molecules, 25:58417
KOROLEV, A. V., Effects of nuclear radiation on the activity of a palladium catalyst for the hydrogenation of butynediol, 25:57448
KOROTKIN, Yu. S., Electromigration separation of transuranium elements in solutions of ethilendiamintetracetic and cyclohex andiamintetracetic acids, 25:57520 (JINR-E6-5952)
Separation of the actinide elements and their valence forms by partition paper chromatography and thin-layer chromatography, 25:57553
KORSUN, V. I., Elimination of the effect of the sample composition on the line intensity of certain rare metal impurities, 25:57330
KORSUNSKII, A. M., Modulated relativistic electron beams, 25:59211
KORSUNSKII, M. I., Temperature dependences of Debye--Waller factors of Zr, Nb, and Mo, 25:59179
KORYTKO, L. A., System for automated one-element activation analysis, 25:57390
KORZHEVENKO, G. N., Protection of animals against injury by nuclear weapons, 25:58026
KOSINA, Z., Linear polarization of low-energy capture γ-rays from ^{35}Cl(n,γ) reaction, 25:59745
KOSKOVA, D., Effect of chronic radiation on results of TEG, 25:58144
KOSSYI, I. A., Influence of longitudinal streams of charged particles on the diffusion of plasma in a stellarator, 25:58975
KOSTA, L., Impurities in analytical and suprapure reagents application of activation analysis for determination of Cl, As, Cu, Mn, Na, 25:57379
KOSTIKOV, V. I., Influence of the nature of a graphite lattice on the rate of impregnation by molten zirconium, 25:58245
KOSTIN, B. F., Search for $\pi^{+} \to e^{+} + \nu$/sub e/ + $e^{+} + e^{-}$ decay, 25:59255 (BNL-tr-451)
Search for the decay $\mu^{+} \to e^{+} + e^{+} + e^{-}$, 25:59254 (BNL-tr-449)
KOSTIR, J., Radiation biochemistry in plants. II, 25:57931
Radiation biochemistry in plants. I, 25:57941
KOSTYANOVSKII, R. G., Radicals in γ-irradiated hydrates of three-membered cycles, 25:57476
KOSTYLEVA, Yu. G., Maintenance of electron equilibrium in the calibration of dosimeters in gamma radiation beams, 25:57860
KOT, Janusz, Intercomparison measurements of SKODA and INR calorimeters on EWA-10 reactor, 25:57875 (INR-1319)
KOTANSKI, A., Decays of interfering resonances and statistical tensors, 25:59461
KOTB, M. A. M., Application of the plasma-quenching effect for emergency and accident radiation monitoring, 25:58017
KOTOVA, L. P., Theory of anomaly of differential scattering cross sections for high-energy atoms, 25:58767
KOTSARENKO, N. Ya., Surface waves in a magnetized plasma, 25:59092
KOTT, J., Intercomparison measurements of SKODA and INR calorimeters on EWA-10 reactor, 25:57875 (INR-1319)
KOURI, Donald J., Low-energy atomic collisions. II, 25:58771
KOUSAKA, Tadako, Positive scintiphotography of cancer of the liver with ^{67}Ga citrate, 25:58045
KOVALEV, V. P., Bremsstrahlung yield as function of target thickness and atomic number in electron energy range 12 to 22 MeV, 25:59106
KOVALEVSKII, I. V., Interplanetary medium and its interaction with the Earth's magnetosphere, 25:58886
KOVENSKAYA, B. A., Electric properties of alloys of LaB$_6$ with transition metals. I, 25:59182
Temperature dependence of electrophysical properties of alloys of LaB$_6$ with transition metals. II, 25:59183
KOVTOUNE, R. I., Resonant interaction of charged particles with a cyclotron wave, 25:59096
KOWALIK, S., Simplified method of analytical determining the coefficient of increase for gamma radiation, 25:57681
KOYAMA, Shinji, Effects of Mn, Si, Cr, and Ni on reaction of solution and precipitation of Nb nitride in Fe austenite, 25:58268
KOZLOV, A. P., Formation of braking radiation beam of medical betatron, 25:59651
KOZLOVSKI, T., Angular distribution of the low energy neutrons from the nuclear μ-capture in sulfur and calcium, 25:59738 (JINR-P1-6029)
KOZLOWSKI, M., Energy dependence of polarization in ^{9}Be(d,p)^{10}Be reaction, 25:59722
KOZLOWSKI, Maciej, Solutions for equilibrium models of He-burning Population I star, 25:58465
KPONOU, Ahovi E. F., Measurement of the $2^{3}P_{0}$-$2^{3}P_{1}$ fine

XUM

structure interval of ^{4}He, 25:58720
KRAEMER, H., Technical and scientific position as well as prospect for nuclear energy in the engineering of the Federal Republic of Germany. II, 25:60012 (JUL-775-RG)
KRALL, Nicholas A., Low-frequency instabilities in magnetic pulses, 25:59069
KRAMER, K. H., Oxidation behaviour of nickel--vanadium alloys in air, 25:58251
KRAMER-AGEEV, E. A., Measurement of fast-neutron spectra with threshold detectors, 25:57775
KRASNOBAEV, K. V., Instability of weak ionization waves of D type, 25:58627
KRATOCHVIL, J., Deoxycytidinuria in persons occupationally exposed to chronic irradiation, 25:58145
KRAUS, G., g-meson, 25:59298
KRAUS, John D., Identification of radio sources from Ohio survey, 25:58558
KRAUSE, H., Treatment and final disposal of radioactive waste, 25:57540
KRAUSE, Herbert Francis, Scattering of deuterium atoms by H, 25:58778
KRAUSE, Manfred O., K--LL Auger spectra of N_2, O_2, CO, NO, H_2O, and CO_2, 25:58736
KRAUSS, O., Operating experience and results obtained with TRIGA research reactor, 25:60173
KREINDLIN, I. I., Detection of defects in butt welds with beta rays, 25:57700
KREISLER, M. N., Experimental study of ω neutral decays, 25:59320
KRESTOVNIKOV, A. N., Structural transformations in cobalt--vanadium melts, 25:58281
KREZHOV, K., Gamma-radiation-induced changes in SiC semiconductor varistors, 25:57903
KRIEGER, H. L., Evaluation of ion-exchange surveillance sampler for analyzing radioactive liquid effluents, 25:57351
KRIKLAVA, J., Effect of chronic radiation on results of TEG, 25:58144
KRIKS, H. J., Investigations on exoelectrons with a special proportional counter, 25:57834
KRINITSYN, A. N., Charged π-meson photoproduction on nuclei at E_0 = 560 MeV, 25:59248
KRISTIAN, Jerome, Spectra of white dwarfs with circular polarization, 25:58447
KRISTIANSEN, M., Global temperature effects of the use of fusion energy and the fusion torch, 25:58956
KRIVISKII, Alexander S., Radioprotective action of Versene on gamma irradiated bacteriophages, 25:58032
KRIVONOZHNIKOVA, L. G., Conditions for cerium sorption by chromatographic paper modified with carboxylic acids for its determination by the peroxide method, 25:57331
KROCK, R. H., Influence of additives on the formation of periodic precipitation (Liesegang bands) in the Ag--Cd system, 25:58262
KROENERT, E., Scintigraphic diagnosis by means of short-lived radionuclides, 25:58060
KROKHIN, Oleg, Laser light for fusion fire, 25:59057
KROMER, H., Complex automation of nuclear power plants, 25:60048
KRONRAD, L., Fast preparation method of ^{32}P applicators, 25:57500
KRONRAD, Leo, Process of manufacturing radioactive substances derived from difluorescenylmercury and labelled with radioactive iodine isotopes, 25:58047
KROO, N., Correlation technique at pulsed neutron sources, 25:59672 (KFKI-71-45)
KROT, N. N., Heptavalent state of neptunium and plutonium, 25:57404
  Heptavalent state of transuranium elements. XII, 25:57412
  Interaction of neptunium with hydrogen peroxide in concentrated solutions of nitric acid, 25:57414
KRUIVER, P. J. G., Present state of analysis of Nd I and Nd II, 25:58705
KRUPPE, H., Production of heat and energy in Federal Republic of Germany, 25:59889
KRYMM, R., Economic outlook for atomic energy, 25:59888
KRYTER, R. C., Investigation of boiling detection in the HFIR using out-of-core instrumentation, 25:60181
KRYZANEK, R., Radiation biochemistry in plants. II, 25:57931
  Radiation biochemistry in plants. I, 25:57941
KUCHOWICZ, B., Evidence for products of rapid neutron capture on surfaces of peculiar A stars, 25:58462
  Two relativistic matter distributions of radial symmetry, 25:59597
KUDRYAVTSEV, A. E., Mass spectrum of (Λp) from reaction $K^-d \to \pi^-\Lambda p$, 25:59522
KUECHLER, L., Thorex two-stage process for reprocessing thorium reactor fuel with high burnup, 25:57541
KUEHN, B., Determination of the neutron--neutron scattering length from a kinematically complete experiment with the reaction ^{3}H(t,n^{4}He)n, 25:59506 (JINR-E15-5905)
KUEHN, E. W., Capacitance characteristics of lithium-drifted pin-diodes mounted together with a cooled FET stage, 25:57802
KUEHN, P. R., Preparation of self-supporting, metallic foils of isotopic chromium, 25:59633 (CONF-711002-, pp 39-46)
KUEPER, K., Processing data in nuclear medicine with the aid of desk-top computers, 25:58065
KUKAVADZE, G. M., Adsorption and desorption of residual gases on a tungsten surface in a strong electric field, 25:58246
KUKULYANSKAYA, M. F., Radiation-induced change of enzyme activity during blocking of the adrenal cortex, 25:57929
KULAKOV, G. V., Physical characteristics of direct-charge detectors, 25:57777
KULCINSKI, G. L., Comparison of displacement rates produced by ion bombardment and neutron irradiation, 25:59144
  Microstructural analysis of neutron-irradiated titanium and rhenium, 25:58302
KULICKI, K., Effect of a steady electric field on the diffusion of oxygen through polycrystalline layers of carbon or vanadium pentoxide, 25:58383
KULIEV, A. A., 0^+ and 1^+ unlike particle-hole states in deformed odd--odd nuclei and β-strength functions, 25:59872
KULIKOV, A. V., Device for connecting the generator tube with the resonance system of a synchrocyclotron, 25:59649
KULIKOV, V. M., Unified description of inelastic and quasielastic electron scattering from nuclei, 25:59869
KUMAMOTO, Yoshikazu, Whole-body absorbed dose from x and gamma rays, 25:58004
KUMAR, Vijay, Rate constants of reactions of photogenerated solvated electrons with monomers, 25:57475
KUME, Sanshiro, Chemical separation in an isotope separation on-line (ISOL) system, 25:57481 (KURRI-TR-76, pp 8-14)
KUMMER, W., Interpretation of anomalies in Ward identities, 25:59572
KUMPF, H., Centering device for nuclear reactor loading machines, 25:60254
  Determination of the neutron--neutron scattering length from a kinematically complete experiment with the reaction ^{3}H(t,n^{4}He)n, 25:59506 (JINR-E15-5905)
KUNA, P., Cardiovascular changes in experimental radiation disease, 25:58122
KUNII, Tosiyasu L., Quark--molecule calculations, 25:59344
KUNST, B., Nuclear power operated de-salination of sea water under nominal and partial load conditions, 25:60201
KUNSZT, Z., Deep inelastic electroproduction of hadrons on a photon target, 25:59333 (JINR-E2-6036)
KURALESOVA, Albina I., Osteogenic precursor cells of bone marrow in radiation chimeras, 25:58121
KURBATOVA, V. I., Determination of cerium in refractory alloys with use of chromatographic separation, 25:57338
KURCEWICZ, W., Decay scheme of ^{232}Pa, 25:59798
  Levels of ^{230}Th and ^{230}U fed in decay of ^{230}Pa, 25:59800
KURIHARA, Masayoshi, Three phase region in system UO_2--PuO_2--Pu_2O_3, 25:58409
KURKA, Gerard, Techniques of continuous measurement of radioactive fission gases evolved in fuel elements, 25:57344 (CEA-R-4218)
KUROCHKIN, S. G., Mass parameter of fission asymmetry, 25:59874
KURZ, R., System for multiparameter pulse height analysis with repeated use of a single, fast ADC, 25:59668
KUSAKA, Y., Rapid determination of boron in glass by prompt γ-ray measurement, 25:57369 (RFP-Trans-83)
KUSAKA, Yuzuru, Rapid chemical separation, 25:57521 (KURRI-TR-76, pp 15-18)
KUSAKABE, Takashi, Non-magnetic resonance scattering in two-band superconductors, 25:58935
KUSHELEVA, A. F., Spectrophotometric determination of small amounts of scandium and yttrium in each others presence, 25:57318
KUSHNER, Sidney R., Enzymatic repair of deoxyribonucleic acid. IV. Mechanism of photoproduct excision, 25:57928
  Enzymatic repair of DNA. III. Properties of the UV-endonuclease and UV-exonuclease, 25:57935
KUWABARA, Goro, ESR investigation of $3d^9$ ions in alkali halides, 25:59201
KUZ'MENKO, P. P., Thermal diffusion of traces of thallium in various molten metals, 25:58267
KUZ'MIN, A. F., Motion of charged particles in approximately orthogonal electric and magnetic fields, 25:59210
KUZ'MIN, A. M., Optimization study of fast reactors, 25:60217
KUZ'MIN, R. N., New Moessbauer ^{57}Co sources, 25:59203
KUZ'MIN, V. V., High-sensitivity thermally stimulated exoelectron emission element for gamma dosimeters, 25:57836
  Sensitive element for radiothermoluminescent dosimeters for gamma and neutron radiations, 25:57849
KUZ'MINA, L. V., Kinetic equation for the passage of μ mesons through matter, 25:59400
KUZ'MISHCHEV, V. A., Effects of thermal cycling of monocrystals of tungsten--molybdenum alloys, 25:58247
KUZNETSOV, L. F., Radioactive isotopes in railway transportation, 25:57672
KUZNETSOV, Yu. V., Question of possible variations in the past concentrations of uranium in the ocean, 25:57588
KUZNETSOVA, I. G., Effect of crystal structure disorder of BN on its sintering, 25:58359
KVARTSKHAVA, I. F., Plasma losses in high-current plasma

XUM

configurations due to the inverse skin effects, 25:58967
Role of recurring discharge ignition in dynamic Z pinch, 25:59015
KVITKO, K. V., Effect of hygromycin B and streptomycin on Actinomyces hygroscopicus variability induced by x-irradiation, 25:57964
KWIATKOWSKA-SIENKIEWICZ, Krystyna, Determination of silicon in pure tellurium, 25:57324
KWIATKOWSKI, Bartlomiej, Influence of uv radiation on pigeon erythrocytes, 25:58113
KYLSTRA, C. D., Plasma diagnostics of a uranium plasma, 25:59000

L

LABAT, P., Phenix reactor, 25:60025
LABNO, Leszek, Intercomparison measurements of SKODA and INR calorimeters on EWA-10 reactor, 25:57875 (INR-1319)
LABRECQUE, Rodney J., Collinear collisions of atom and Morse oscillator, 25:58727
LABROUSSE, M., Intercomparison measurements of SKODA and INR calorimeters on EWA-10 reactor, 25:57875 (INR-1319)
LABZOVSKII, L. N., Ground state energy of two-electron atoms with arbitrary nuclear charges Z less than or equal to 137, 25:58818
LACERANZA, Angela Maria, Fragment yields for the fission of ^{209}Bi induced by a 1000-MeV bremsstrahlung, 25:59816
LACOMBE, P., Aging of ternary Fe--Ni--Mo and quaternary Fe--Ni--Co--Mo alloys, 25:58232
Does oxidation of Zr obey Wagner's theory, 25:58254
LACOUR-GAYET, Philippe, Stress changes in Ta carbide with deformation rate and temperature (1,200 and 2,200°C), 25:58395
LACY, Jeffrey Linn, Eta pi decay of the A2 meson and A2 production mechanism, 25:59279
LAFONTAINE, I., Perspectives of plutonium utilization seen from 1970, 25:60249
LAKEY, J. R. A., Monitoring system for the assessment of reactor shield performance, 25:57779
LAL, K., Agents protecting skin against acute radiation, 25:58036
LAL, K. C., Equivalence of gravitational red shift and temperature shift in Moessbauer effect, 25:59596
LAL, S., Ratio of pions to protons and ratio of neutral-to-charged interacting particles at 800 gm/cm^2, 25:58834
LALLIA, P., Plasma heating at the lower-hybrid resonance, 25:58960 (CEA-CONF-1831)
LAM, C. S., Dual-resonance model with unequal intercepts, 25:59441
Flat proton spectrum and its implications, 25:59511
LAM, S. K., Milne's problem for two-dimensional transport in a quarter space, 25:59112
LAM, W., New measurements of $(\pi^+,2p)$ reactions on light nuclei, 25:59709 (LA-DC-12389)
LAM, W. C., Cross sections for (π^+,p) reactions on ^{9}Be, ^{12}C, and ^{16}O, 25:59710 (LA-DC-12781)
LAMARCHE, J. L. G., Sensitivity of nuclear emulsion at very low temperature, 25:57829
LAMB, Eugene, ORNL isotopic power fuel quarterly report for period ending June 30, 1971, 25:57658 (ORNL-4723)
LAMB, Marion J., Effect of radiation on small competing populations of Drosophila melanogaster. IV. Changes in longevity, 25:57961
LAMBERT, D. L., Abundance of chlorine in Sun, 25:58593
LAMEL, David Arthur, ^{18}F uptake in normal, x-irradiated, and fractured bone, 25:58105
LAMOT, G.-H., Non-exhaustive restatement of the angular momentum reduction in the three-body problem, 25:59206 (LYCEN-7118)
LAMPTON, Michael, Evidence for a highly compact x-ray source, 25:58534
LANDA, L. M., Radiation effects on glass and ceramics, 25:59147
LANDIS, D. A., Pulsed feedback techniques for semiconductor detector radiation spectrometers, 25:57812
LANDOLT, Arlo U., Subluminous B-Type star CD -42° 14462, 25:58456
LANDSBERG, P. T., Ensemble versus time average probabilities in relativistic statistical mechanics, 25:59238
LANDSHOFF, P. V., Two high energy processes involving detected final state particles, 25:59401
LANE, A. M., Nuclear resonance reactions in 1967, 25:59847
LANE, Kenneth, CP-invariance violation as second-order weak effect, 25:59540
LANG, Neil C., Velocity corrections for total scattering cross sections, 25:58757
LANGENHORST, J. W., Eye-controlled versus hand-controlled tracking, 25:60288 (SC-RR-710502)
LANGER, I., Modification of x-ray radiation effects by means of chemical substances, 25:57974
LANGEVIN-JOLIOT, H., Elastic and inelastic scattering of 80-MeV deuterons, 25:59754
LANGMEAD, W. A., Sealed thermoluminescent dosimeter employing rf heating for routine individual monitoring, 25:57839
LANGSDORF, A., Energy control and monitoring system for a tandem Van de Graaff, 25:59653
LANIN, A. G., Residual stresses in cermets, 25:58381
LANZEROTTI, L. J., Conjugate geomagnetic studies near the plasmapause, 25:58898
LA PAGLIA, S. R., Electronic transition moment of Lyman bands of H_2, 25:58699
LAPIN, N. I., Charged π-meson photoproduction on nuclei at E_0 = 560 MeV, 25:59248
LARINA, L. S., Alloying of Magnico alloy with Nd, 25:58250
LARIONOV, M. M., Methods of investigation of turbulent phenomena in plasma by scattering of shf waves, 25:58996
LAROSE, James H., Eye tumor identification tests using semiconductor detectors, 25:58064
Medical problems in eye tumor identification, 25:58063
LARSEN, R. P., Chemical Engineering Division. Cross sections and burnup semiannual report, January--June 1971, 25:60035 (ANL-7824)
LARSEN, R. S., CAMAC dataway and branch highway signal standards, 25:57880
LARSON, H. V., Intercomparison of the characteristics of beta/gamma and neutron survey instruments, 25:57782
LARSON, J. M., ^{111}In: new radioisotope for cysternoscintillography, 25:58052
LASINSKI, T., Improved partial wave analysis of anti KN + anti KN from 800 to 1200 MeV/c, 25:59293
LASKORIN, B. N., Ion exchange fibers and fabrics. II, 25:57555
LASS, James Lloyd, Nuclear fuel retainer, 25:60246
LATHROP, K. D., Properties of new numerical approximations to the transport equation, 25:59113
LATYSHEV, L. A., Determination of parameters of nonequilibrium plasma in a restricted volume allowing for step-wise ionization, 25:59034
LAUBER, A., Miniaturized needle-type semiconductor detectors for in-vivo measurements of tracer activity, 25:57744
LAUER, K. F., Assay of samples for nuclear measurements by counting and chemical analysis, 25:57345 (CONF-711002-, pp 293-306)
LAUNODIS, D., Plasma confinement in the DECA II B circularized magnetic well, 25:58958 (CEA-CONF-1807)
LAURENCE, G., Phonon scattering and induced energy levels in electron-irradiated Sb-doped Ge, 25:59134
LAURENZI, Bernard J., Green's function for H_2^+, 25:58704
LAVAL, G., Dissipative instability associated with electrons trapped in tokamak-type configurations, 25:59060 (CEA-CONF-1800)
LAVAL, M., Multiple proportional gas counter for the cartography of radioelements, 25:57774
LAVENDER, A., Energy response of some commercial beta/gamma and neutron survey instruments, 25:57781
LAVRENCIC, D., Heavy water production, industrial processes, and plants, 25:57652 (DAISE-70-8)
LAVRENIKOV, V. D., Some integral-reactivity properties and their application to IGR reactors, 25:60171
LAVROV, M. I., Simple method for determining photometric orbital elements, 25:58427
LAWLESS, J. L., Computer controlled instrumentation for plutonium measurement, 25:57897
LAWRENCE, Dennis O., Instrument for the measurement of auroral electrons and protons, 25:57790
LAWRENCE, G. P., Polarization transfer in reaction T(p,n)^{3}He at 0° for E/sub p/ in range 3 to 16 MeV, 25:59695
LAWRENCE, James L. Jr., Instrument for the measurement of auroral electrons and protons, 25:57790
LAWRENCE, L. A., Melting heat rating of UO_2--25 wt. percent PuO_2 fuels, 25:60243
LAWSON, C. G., Heat transfer from electrically heated rods during a simulated loss-of-coolant accident, 25:60114 (CONF-711103-1)
LAYZER, David, Cosmic evolution and thermodynamic irreversibility, 25:58672
LAZARESCU, G. A., Kinetic parameters determination in a natural uranium-light water lattice by the pulsed source technique, 25:60166
LAZAREV, B. G., Anomalous behavior of the superconducting transition temperature of lead with a distorted crystal lattice, 25:58533
LEA, Suzanne Moore, Studies in quadrupole Coulomb excitation, 25:59859
LEACH, Peggy Ann, Gene and chromosomal behavior in a parasitic wasp, 25:57962
LEBECKA, Jolanta, Application of the tracer method in investigations of evaporation phenomena in power boilers, 25:57674
LEBEDEV, N. A., Emission-spectral and radioactivation analysis of yttrium oxide with preliminary concentration of rare earth impurities by extraction chromatography, 25:57372
LEBIN, A. Ya., Inelastic pion--nucleon interactions with high multiplicity and the one-pion exchange model, 25:59496
LEBRETON, P. R., Electronic excitation in fast collisions of Na with SO_2 and NO_2, 25:58749
LECOUSTEY, P., Plasma confinement in the DECA II B circularized magnetic well, 25:58958 (CEA-CONF-1807)
LEDENEV, O. P., Diffusion of substrate atoms into a surface film as indicated by the secondary ion--ion emission characteristics, 25:58266
LEE, J. C., Brandow boson linked-cluster expansion applied

to the high-density charged boson gas, 25:59229
LEE, Kai Fong, Ordinary-mode electromagnetic instability in colliding plasma streams, 25:59065
LEE, S. Y., T invariance and unitarity limit in K/sub L/° $\to$ $\mu^+\mu^-$, 25:59543
LEE, T. D., Algebra of fields, 25:59324
LEE-FRANZINI, J., Particle momentum distributions for 8.5-GeV/c π^+p interactions, 25:59317
  Strangeness-changing leptonic decay rates for Σ^+-hyperons, 25:59261
LEGGETT, A. J., Mass and spin diffusion near lambda line in dilute ^{3}He--^{4}He mixtures, 25:58926
LEHNER, G., Vacuum magnetic fields of linear stellarators with shaped coils, 25:59074 (IPP-1/119)
LEHR, P., Kinetics of zirconium oxidation under low oxygen pressures, 25:58175
LEIBER, C. O., Dynamic behavior of dispersed inhomogeneous systems, 25:58380
LELOUP, C., Electrostatic instabilities in a two-component anisotropic plasma, 25:59061 (CEA-CONF-1828)
LEMANSKA, M., Solution of multi-dimensional, multigroup diffusion equation using Lie series method bare reactor, 25:60233
LEMERIE, M. Y., Specific heat of neutron irradiated graphite between 1.4 and 4.4°K in presence of a variable magnetic field (0 to 40 kGs), 25:59148
LEMESHKO, A. M., Electro-erosion resistance of refractory carbides within corresponding ranges of homogeneity, 25:58356
LEMMER, R. H., Calculation of the pion--nucleus optical potental, 25:59516
LEMONTT, Jeffrey Fielding, Genetic control of mutation induction in Saccharomyces cerevisiae, 25:57976
LENGEMANN, F. W., Resolution of two β-emitting radionuclides by liquid scintillation counting, 25:57353
LENGER, V., ^{226}Ra activity determination in non-equilibrium state by scintillation gamma spectrometry, 25:57365
LENGYEL, Lajos L., Current and potential distributions in nonequilibrium MHD plasmas, 25:58844
LENKSZUS, F. R., Computer controlled CAMAC systems at Argonne, 25:57884
LEONARD, A., Chromosome aberrations in persons exposed chronically to ionizing radiations, 25:57972
  Milne's problem for two-dimensional transport in a quarter space, 25:59112
LEONARD, B. E., Analytical pulse reactor model with delayed neutrons, 25:60223 (AD-721076)
LEONARD, E. D., Chromosome aberrations in persons exposed chronically to ionizing radiations, 25:57972
LEQUEUX, J., Radio continuum of galaxies. I, 25:58645
  Radio continuum of galaxies. II, 25:58646
LERNER, Jerry, Preparation of nuclear research materials with a laboratory-type isotope separator, 25:57649 (CONF-711002-, pp 1-9)
LESIGNE, B., Transient species in the pulse radiolysis of periodate ion in neutral aqueous solutions, 25:57466
LESSOR, D. L., Neutron spectra from (a,n) reactions in plutonium compounds calculated from Hauser--Feshbach reaction theory, 25:59708 (BNWL-B-109)
LESTRINGUEZ, J., Cross sections for the production of beryllium isotopes from the 880 MeV alpha-particle bombardment of carbon, 25:59733
LEUNG, Y. C., Limiting mass of a neutron star, 25:58564
LEV, A., Isobaric mass equation in A = 4n + 1 nuclei, 25:59882
LEVIN, M. P., Calculation of the characteristics of stabilized electric arc heating of gases at high pressures, 25:59059
LEVINA, V. I., Production of $\pi^+2\pi^-$ on nuclei at small momentum transfers, 25:59316
LE VINE, M. J., Reaction ^{12}C(^{14}N,^{6}Li)^{20}Ne and structure of upper $K = 0^+$ bands, 25:59743
LEVINSKII, Yu. V., Effect of nitriding on the properties of tantalum, 25:58259
LEVITSKY, S., Experimental evaluation of a radioisotope-powered cardiac pacemaker, 25:57669
LEVITZ, N. M., Chemical Engineering Division fuel cycle technology quarterly report, January--March 1971, 25:57507 (ANL-7799)
LEVY, N., rho-exchange contribution to $\gamma n \to$ rho$^-$p, 25:59385
LEVY, R., Fast neutron irradiation of Al, Mg, and Cu, 25:58310
LEVY, V., Fast neutron irradiation of Al, Mg, and Cu, 25:58310
LEWCZUK, Jacek, Application of the tracer method in investigations of evaporation phenomena in power boilers, 25:57674
LEWIS, A. E., Nuclear chimneys: underground containers for chemical and metallurgical processing, 25:57604 (UCRL-73130)
LEWIS, Edward S., Ordering of carbon--hydrogen bond strengths using isotope effects, 25:57426
LI, Ling-fong, Breaking Nambu--Goldstone chiral symmetries, 25:59541
LIAW, Chiu-fong, Behavior of Np in aqueous solution. II, 25:57535
LIBCHABER, A., Transport properties and phase coherence in superfluid helium, 25:58914
LIE, H. P., Conjugate geomagnetic studies near the plasmapause, 25:58898
LIEB, D., Thermionic performance of CVD tungsten emitters, 25:58839 (TEE-4125-5)
LIEBENBERG, D. H., Potential-probe dissipation measurements in a flowing superfluid helium film, 25:58925
LIEBERMAN, Edward M., Ultraviolet radiation effects on isolated nerve fibers, 25:57939
LIESER, Karl-Heinrich, Generator substance for producing radioactive /sup 137m/Ba, 25:57484
LIETZ, G., T(d Vector,n)^{4}He reaction with polarized deuterons at energies above 107-keV resonance, 25:59705
LIEWER, Paulett C., Low-frequency instabilities in magnetic pulses, 25:59069
LIGHTBODY, David, ISIS: program for computerized fission data analysis, 25:59773 (AD-721481)
LILENFELD, H. V., Velocity corrections for total scattering cross sections, 25:58757
LILLIE, Richard A., Theoretical nuclear analysis of MH-1A: Cores 2 and 3, 25:60203 (AD-721019)
LIMANDAS, M., Counting tritiated water, 25:57363
LIN, K. C., Heat treatment studies of infrared absorption in reactor-irradiated Ge, 25:58343
LIN, Tsing-ko, Hot-atom chemistry of polyphosphates. IV, 25:57495
LIND, D. A., New (p,n) reaction studies at Ep = 23 MeV, 25:59789
LINDALEN, H. R., Variations in high-latitude proton trapping boundary, 25:58866
LINDENBAUM, S. J., Experimental verification of dispersion theory and high energy scattering, 25:59424
LINDSAY, J. D. G., New high-temperature phase of protactinium metal, 25:58291
LINDSAY, John W., Evaluation of methods to recover plutonium from incinerator ash, 25:57525 (RFP-1723)
LINEKAR, G. A. B., Electron microscope observations of voids in cladding materials irradiated in DFR, 25:58307
LINHART, G., Manufacturing and in vivo application of miniaturized semiconductor detectors, 25:57745
LINIECKI, Julian, Method for determining the mass of dust deposited on membrane filters by measurements of the absorption of beta rays, 25:57870
LINNEMANN, Roger E., Regional approach to the management of radiation accidents, 25:58039
LIPATOV, L. N., Bremsstrahlung in backward e^+e^- scattering as multi-Regge process, 25:59369
  Bremsstrahlung in e^+e^- backward scattering at high energies, 25:59374
LIPKIN, H. J., Group theory and theoretical physics, 25:59530
LIPOVKA, N. M., Structure of the radio source Sagittarius A, 25:58624
LISHANSKII, B. A., Investigating the vibrocompacting of concrete mixes with the use of radioisotopes, 25:57869
LISIN, V. N., Transformer for accelerator tube, 25:59648
LISOVSKII, I. P., Effect of slowing-down neutrons in the sample on the results of activation analysis, 25:57377
  Express determination of yttrium in rare earth concentrates by the method of activation with fast neutrons, 25:57382
  VVR reactor semiautomatic activation analysis system, 25:60168
LITCHFIELD, P. J., Partial wave analysis of $K^-N \to \Lambda\pi$ between 1.0 and 1.85 GeV/c, 25:59303
LITHERLAND, A. E., K/sup π/ = 1^+ rotational band in ^{18}F, 25:59715
LITMAN, A. P., Mass transfer between Hastelloy N and Haynes alloy No. 25 in a molten sodium fluoroborate mixture, 25:58169 (ORNL-TM-3488)
LITOVITZ, T. A., Nuclear-particle track detection using liquid--liquid phase separation: the glass chamber, 25:57727
LITTLE, J. B., Repair of potentially-lethal radiation damage in mammalian cells, 25:58081
LITTLEJOHN, M. A., Range-energy calculations of heavy ions in Si, 25:59116
LITZEN, Ulf, Resonance lines of La III, 25:58707
LIU, C. H., Interaction of internal gravity waves with the F2 layer, 25:58872
LIU, K. H., Finite-range interaction in deuteron stripping reactions, 25:59854
  Prog. rpt. on research in experimental and theoretical nuclear physics, annual, 7/15/71, 25:59841 (ORO-4119-1)
LIU, Y. M., Electron radiation damage effects in silicon surface-barrier detectors, 25:57907
LIVINGSTON, A. E. Jr., Spectra of neutral and singly ionized holmium, 25:58708
LIVINGSTON, W., Solar rotation: direct evidence from prominences for a westward wind, 25:58601
LLEWELLYN, E. J., Study of (4-1) and (5-2) hydroxyl bands in night airglow, 25:58902
LLOVERAS, Jacques, Effect of γ radiation on phospholipase A activity of Sticker sarcoma, 25:57940
LLOYD, Ray D., Photon detector utilizing a well-type scintillation crystal, 25:57759
LOBANOV, E. M., Determination of impurities in pyrographite by method of delayed coincidences of β and γ radiation, 25:57389
  Neutron activation determination of cobalt by nondestructive means, 25:57386

XUM

LOBANOV, F. I., Group concentration of elements by extraction with a hydroxyquinoline melt, 25:57312

LOBAR, W., Photoproduction of π^0's from neutrons at 4 GeV, 25:59243

LODATO, Vincent A., Temperature dependence for destruction of metastable $He(2^3S)$ atoms, 25:58731

LOESER, Rudolf, Radiative transfer in two-component stellar atmospheres, 25:58468

LOFTNESS, Robert L., Nuclear power abroad: a time of change, 25:60024

LOH, S. Y., Heat treatment studies of infrared absorption in reactor-irradiated Ge, 25:58343

LOHE, M. A., Boson calculus for the orthogonal and symplectic groups, 25:59534

LOHRDING, Ronald K., Economic vs biological risk as reactor design criteria, 25:60003

LOKAN, K. H., Optical measurements on solvated electrons in pulse-irradiated liquid propane, 25:57468

LOKTIONOV, N. F., Nonisothermal superconducting bolometer. II, 25:58952

LOMAKIN, S. S., Use of fission chambers in water-cooled reactors, 25:60046

LONG, Christopher Eugene, Temperature dependent electrostatic interactions between magnetic ions in uranium monophosphide, 25:59189

LONG, E. L. Jr., Failure of aluminum tubing in the ORNL 86-inch cyclotron, 25:59643 (ORNL-TM-3523)

LONGO, M. J., Isospin invariance in reaction $np \rightarrow \pi^0 d$, 25:59268

LOOPSTRA, B. O., Sodium uranates: preparation and thermochemical properties, 25:57405

LOPEZ, A., Pollution of the atmosphere in uranium mines, 25:57564

LOPUSZYNSKI, Jerzy, Intercomparison measurements of SKODA and INR calorimeters on EWA-10 reactor, 25:57875 (INR-1319)

LORE, J., Development of properties of nuclear graphite obtained by a mixture of cokes, 25:58366 (CEA-CONF-1820)

LORENZ, W. J., Operating experience and results obtained with TRIGA research reactor, 25:60173

LORETTO, M. H., Conference on voids formed by irradiation of reactor materials, Reading, Eng., 3/71, 25:58304
  Voids in intermetallic compound NiAl, 25:58318

LOS, J., Diffusion coefficients of isotopic methane mixtures and of methane--rare gas mixtures, 25:57434

LOSKUTOV, A. I., Anodic dissolution of hard alloys of VK type in alkali--nitrate electrolytes, 25:58177

LOUIE, J., Reaction $\pi^+ p \rightarrow \Sigma^+ K^+$ at 1.28 and 1.41 GeV/c and a test of charge independence, 25:59311

LOUIS, W. J., Double-isotope derivative plasma assay for noradrenaline and adrenaline, 25:57914

LOVALLO, J. M., Automatic-ranging picoammeter for reactor control and protection, 25:57899
  Lynchburg Pool Reactor protective system instrumentation, 25:60186

LOVAS, Istvan, Resonance phenomena in nuclear reactions, 25:59876

LOVE, Carl G., Nonlinear dynamic optimization technique for controlling xenon induced oscillations in large nuclear reactors, 25:60236

LOVE, L. O., Use of an electromagnetic isotope separator in preparing special research samples, 25:57650 (CONF-711002-, pp 10-20)

LOVELESS, R. J., Particle momentum distributions for 8.5-GeV/c $\pi^+ p$ interactions, 25:59317
  Strangeness-changing leptonic decay rates for Σ^{+-} hyperons, 25:59261

LOVELL, A. J., Mechanical properties of fast reactor irradiated austenitic stainless steel weldment materials, 25:58296 (HEDL-SA-196)

LOVELL, Bernard, Sporadic outbursts of red-dwarf stars, 25:58443

LOW, F. J., Map of galactic nucleus at 10 μm, 25:58639

LUDEMANN, C. A., System for multiparameter pulse height analysis with repeated use of a single, fast ADC, 25:59668

LUDYNSKI, Zbigniew, Utilization of W in Polish industry, 25:58164

LUECKE, Kurt, Kinetics of hydrogen engassing of delta--zirconium hydride, 25:58373
  Lattice parameter and density of zirconium hydride phase, 25:58402

LUKASIAK, A., Theoretical estimates of lifetimes of superheavy nuclei, 25:59803

LUKIERSKI, J., Bilocal field operator describing an arbitrary two-particle state, 25:59583

LUKIN, A. M., Rezarson as a reagent for the spectrophotometric determination of niobium, 25:57333

LUNDIN, Carl D., Scanning electron microscopy of fractures in welded structures, 25:58215 (Y-DA-4280)

LUR'E, K. A., Optimal distribution of tensor of specific resistance of working substance in MHD duct, 25:58845

LUR'E, T. L., Competitive capacity of Drosophila individuals heterozygous for x-ray induced mutations, 25:57966

LUSANNA, L., Remarks on inclusive experiments and high energy models, 25:59322 (NP-19024)

LUTHMAN, Per Kurt, Pre-stressed concrete pressure vessel, 25:60069

LUTZ, Thomas E., UBV observations of visual double stars, 25:58457

LUTZE-BIRK, A., Excitation of x rays for investigation of diffusion, 25:57673

LYNCH, Gerald R., Efficient Monte Carlo event generation method for multiperipheral models, 25:59213

LYNE, A. G., Characteristics of the radio pulses from the pulsars, 25:58545
  Mode changing in pulsar radiation, 25:58569

LYNK, E. T., Prog. rpt. on research in experimental and theoretical nuclear physics, annual, 7/15/71, 25:59841 (ORO-4119-1)

LYNNWORTH, L. C., Nuclear reactor applications of new ultrasonic transducers, 25:57898

LYSAK, Yu. D., Study of a tissue-equivalent spherical proportional counter, 25:57853

LYUDVIGOV, R. B., Experimental studies of power increase in In--Ga radiation loops, 25:60170

M

MACEDO, P. B., Nuclear-particle track detection using liquid--liquid phase separation: the glass chamber, 25:57727

MACEK, R., Cross sections for (π^+,p) reactions on ^9Be, ^{12}C, and ^{16}O, 25:59710 (LA-DC-12781)
  New measurements of $(\pi^+,2p)$ reactions on light nuclei, 25:59709 (LA-DC-12389)

MACHABELI, G. Z., Relaxation and temperature difference in quasi-linear approximation from calculations of collisions for magnetoactive plasma, 25:59007

MACHEN, D. R., CAMAC systems at LAMPF, 25:59654

MACHIDA, Kenji, Performance of clinical linear accelerator, 25:59661

MACK, Dick A., Summary of CAMAC: status and outlook, 25:57888

MACKOUSE, E. M., Radiative corrections to inelastic e^-p scattering, 25:59366

MACNAUGHTON, J., π^+p elastic scattering at 3.6 GeV/c, 25:59292

MADDOCK, A. G., Chemical effects of nuclear transformations in alkali chlorides. III, 25:57503

MADDOCK, B. J., Superconductive composites, 25:58951

MADDOCK, R. O., Analysis of the reaction $\pi^+p \rightarrow$ rho$^0\Delta^{++}$ at 11.7 GeV/c incident momentum. I, 25:59315
  Analysis of the reaction $\pi^+p \rightarrow$ rho$^0\Delta^{++}$ at 11.7 GeV/c incident momentum. II, 25:59499

MADELAINE, G. J., Pollution of the atmosphere in uranium mines, 25:57564

MADER, W., Texture parameters by optical and electron-microscope pictures of WC-, Co-, TiC-, and TaC-alloys, 25:58403

MADEY, John Michael Julius, Emission of slow positrons, statistical variations in the electrostatic potential, and stimulated emission of magnetic bremsstrahlung, 25:58681

MAEDER, G., Aging of ternary Fe--Ni--Mo and quaternary Fe--Ni--Co--Mo alloys, 25:58232

MAERK, Tilmann D., Ion production and loss processes in helium--nitrogen mixtures, 25:59014
  Production and loss of N_2^+, Ne^+, and Ne_2^+ during decay period of plasmas produced in Ne--N mixtures, 25:59019

MAERKER, R. E., Prog. rpt. on fast reactor shielding, 8/71, 25:60055 (ORNL-TM-3573)

MAESTRO, A., Clinical and technical observations in therapy with 42 MeV betatron, 25:58076

MAGGIORE, C., Determination of trace elements in samples by nuclear scattering and reaction techniques, 25:57360

MAGIDOV, M. B., Study of hardening during fatigue of various pure metals, 25:58223

MAGLIC, Bogdan C., Fusion reactions in self-colliding orbits, 25:59078

MAGNO, L., Tangential pendular cobalt therapy in the management of breast cancer, 25:58071

MAHMOUD, K. A., Application of the plasma-quenching effect for emergency and accident radiation monitoring, 25:58017

MAHON, R., Optical generation of electron plasma waves, 25:59101

MAIER-BORST, W., Operating experience and results obtained with TRIGA research reactor, 25:60173

MAIER II, William B., Collisions between low-energy N^+ and N_2, 25:58735
  Reactions between N_2^+ and N_2^*, 25:58751

MAIER-KOMOR, P., Simple technique of producing thin carbon films, 25:58346 (CONF-711002-, pp 144-6)

MAISSIN, Jacques, Effect of neutron irradiation on high temperature mechanical properties of age-hardened 80-20 Ni--Cr alloy, 25:58295 (FRNC-TH-64)

MAISTERRENA, Jorge A., ^{75}Se-selenomethionine in scintallography of thyroid and hepatic lesions, 25:58054

MAKAR'INA, L. A., Magnetic moment of Λ^0 hyperon, 25:59294

MAKAROV, V. I., Profiles of coronal lines based on large coronograph observations, 25:58572

MAKAROVA, T. P., Thin-layer electrophoresis in inorganic analysis. I, 25:57299

MAKAROVA, V. V., Profiles of coronal lines based on large coronograph observations, 25:58572

MAKHANEVA, G. I., Physical characteristics of direct-charge detectors, 25:57777

MAKHLIN, N. A., Influence of crystal lattice defects on

high-energy proton shadow effect, 25:58275
MAKHON'KO, K. P., Conference on radioactivity of the atmosphere, Obninsk, USSR, 7--8/68, 25:57576
MAKI, Arthur G., Rotational constants for HCN and DCN, 25:57423
MAKI, Kazumi, Dynamical fluctuation of order parameter and diamagnetism of superconductors. I, 25:58945
  Higher order effects due to superconducting fluctuation on electrical conductivity, 25:58930
MAKIHIRA, Tsuneichi, High density theta-pinch plasma preionized by shock wave, 25:59056
MAKIN, M. J., Production of voids in Cu by electron irradiation in 1 mV electron microscope, 25:58327
MAKINO, F., Observation of cosmic soft X rays, 25:58548
MAKINO, Isao, Isotope dependence in K, L, and M shell ionization cross sections by $^{3}He^{+}$ and $^{4}He^{+}$ bombardments, 25:58776
MAKOV, B. N., Plasma potential measurement, 25:58992
MAKRA, S., Calculations of dose fractions of slow, intermediate, and fast neutrons behind different shields, as well as readings of selected dosimeters, 25:57858
MAKYAGIN, V. S., Diffuse radiation of Galaxy in far uv, 25:58638
MALASPINA, A., Methods, technique, and clinical results with preoperative radiotherapy in 487 cases of breast cancer, 25:58073
MALATOVA, I., Evaluation method of the gamma spectrometrical determination of radium in state of non-equilibrium, 25:57506
MALDONADO, C. D., Modification of the TRAC Ebers--Moll model for improved high frequency and collector storage time predictions, 25:57904
MALDYBAEVA, E. Ya., Singularity on the general theory of relativity, 25:59595
MALEK, Prokop, Process of manufacturing radioactive substances derived from difluorescenylmercury and labelled with radioactive iodine isotopes, 25:58047
MALEN, K., Void lattice in molybdenum, 25:58313
MALEWICKI, R. L., Chemical Engineering Division. Cross sections and burnup semiannual report, January--June 1971, 25:60035 (ANL-7824)
MALININ, S. A., World use of atomic energy, 25:60296
MALLIA, E. A., Abundance of chlorine in Sun, 25:58593
MAL'TSEVA, G. K., Temperature relaxation in metals, 25:58241
MALYSHEV, E. K., Use of fission chambers in water-cooled reactors, 25:60046
MAMATALIEV, U., Effect of ionizing radiation on mitotic activity of cultured cells, 25:58080
MANASSAH, Jamal T., Hadron electrodynamics in the resonance model, 25:59386
MANCHESTER, R. N., Excitation temperatures of 18-cm OH transitions in absorbing cloud, 25:58560
  Observations of pulsar polarization at 410 and 1665 MHz, 25:58551
MANDELSTAM, Stanley, Dispersion theory and complex J-plane, 25:69425
MANDELSTAM. S., S-matrix theory, 25:59614
MANDEL'TSVEIG, V. B., New type of baryon resonances, 25:59500
  Possibility of observing quasinuclear meson resonances in colliding $e^{+}e^{-}$ beams, 25:59358
MANDZY, John, Di-pion production and two-body annihilations in antiproton--proton interactions at 7 GeV/c, 25:59267
MANFREDINI, A., Photofission of ^{232}Th near threshold, 25:59786
MANGIALAJO, M., Setting-up of a neutron dosimeter using ionographic tracks in an insulating solid, 25:57856
MANIDA, S. N., Investigation of total radiative corrections to ratio G/sub β//sup V//G/sub μ/, 25:59416
MANN, Leland A., Fluid irradiating apparatus using gamma rays and helical passageways, 25:57636
MANOVA, T. G., Influence of various carriers in the spectrographic analysis of oxides of refractory metals (tungsten and zirconium), 25:57335
MANSBACH, Peter Allen, Deser--Laurent theory of gravitation and other topics, 25:59585
MANTHORPE, S. A., Production of voids in cobalt during ion bombardment and electron irradiation, 25:58325
MANTZ, A. W., Infrared bands of $H^{12}C^{15}N$, $D^{12}C^{15}N$, and $H^{13}C^{15}N$, 25:57421
MAPLE, M. B., Low-temperature electrical resistivity of YCe under pressure, 25:59195
MARATECK, S., Low mass I = 0 S-wave $\pi\pi$ phase shift, 25:59306
MARCHETTI, M. A., Electronic transition moment of Lyman bands of H_{2}, 25:58699
MARCHIONNI, V., Radiotoxicological analyses used at CNEN, 25:57347 (RT/PROT-(71)9)
MARCHIORO, C., Exact ground state of some one-dimensional N-body systems with inverse (Coulomb-like) and inverse-square (centrifugal) pair potentials, 25:59840 (NP-19027)
MARCILLE, Melle G., Cellular ultrastructure and mitotic index of lymphocytes of leukemia during treatment by irradiation, 25:58131 (CEA-CONF-1768)
MARCUS, L., Elastic and inelastic scattering of 80-MeV deuterons, 25:59754
MARDER, B. M., High-frequency electrostatic plasma instabilities, 25:59067
MARENIN, Irene R., Technetium in Mira variable RZ Pegasi, 25:58459
MARGADONNA, Daniele, Fragment yields for the fission of ^{209}Bi induced by a 1000-MeV bremsstrahlung, 25:59816
MARGON, Bruce, Evidence for a highly compact x-ray source, 25:58534
MAR'INA, V. V., Effect of fertilizers and seed irradiation on corn plants, 25:58154
MARINESCU, L., Absolute measurement of ^{239}Pu fission cross-section for 2200 m/sec neutrons, 25:59777 (IFA-NR-33)
MARINOV, M. S., Method to calculate amplitudes for scattering of fast particles on nuclei, 25:59528
MARINOVA, Ts. S., Adsorption and desorption of ytterbium on carbonized tungsten, 25:58228
  Desorption of ytterbium and neodymium from tungsten by an electric field, 25:58230
MARIOTTINI, S., Spectrophotometric determination of Cd in nuclear-grade Zircaloy-2 after selective extraction with liquid anion-exchanger, 25:57326
MARK, Harry B. Jr., Neutron activation analysis of trace metal ions, 25:57393
MARK, James W.-K., Collective instabilities and waves for inhomogeneous stellar systems. II, 25:58656
MARK, S. K., Decay of ^{68}As, 25:59747
MARKOCZY, G., Core heat transfer and fluid flow in the GCFR, 25:60059 (CONF-710606-14)
MARKOVA, I. A., Alloys of yttrium with dysprosium and holmium, 25:58274
MARLOWE, M. O., Prog. rpt. on fission gas re-solution rates, 4--6/71, 25:58411 (GEAP-12217)
MARONI, V. A., Prog. rpt. on physical chemistry of liquid metals and molten salts, semiannual, 1--6/71, 25:58387 (ANL-7823)
MARRS, Len F., Underground leaching of uranium at the pitch mine, 25:57536
MARSH, O. J., Disorder produced in SiC by ion bombardment, 25:59171
MARSHALL, Christopher H., Environmental contamination with ^{131}I related to the treatment of hyperthyroidism and carcinoma of the thyroid gland, 25:58079
MARSHALL, M., Surface dosimetry using thermoluminescent discs, 25:57837
MARTELL, A. E., Structure and conformation of Th(IV) complexes of diethylenetriaminepentaacetic acid in aqueous solution, 25:57436
MARTELLUCCI, S., Applications of laser-produced plasma to controlled thermonuclear fusion, 25:59058
MARTIN, A., Monitoring system for the assessment of reactor shield performance, 25:57779
MARTIN, A. H. M., Compact radio sources in the galactic nucleus, 25:58555
MARTIN, B. R., Neutral kaon decays into muon pairs and violation of CP invariance, 25:59544
  S- and P-wave $K^{+}p$ scattering below 600 MeV/c, 25:59489
MARTIN, I., Extraterrestrial γ-ray contribution between 0.7 and 4.5 MeV, 25:58832
MARTIN, J. L., Stress changes in Ta carbide with deformation rate and temperature (1,200 and 2,200°C), 25:58395
MARTIN, James Weldon, Some effects of ionizing irradiation on the microfungal populations of Quercus rubrumlitter, 25:58150
MARTIN, P. G., Interstellar grain alignment by a magnetic field, 25:58647
MARTIN, T. G., Determination of trace elements in soils and clay minerals by resonance neutron activation analysis, 25:57375
MARTIN, W. C., Z dependence of spin--orbit coupling, 25:58716
MARTIN, W. R., Experimental investigation of fabrication of Th--20 wt. percent U for the UMBR fuel element, 25:58185 (ORNL-TM-3499)
MARTINHO, E., FORTRAN LFEN-FR 10: diffusion length of thermal neutrons in moderators from experimental distributions of neutron flux, 25:60226 (LFEN-NI.-60-a)
MARTINOT, L., Electrochemistry of Pu(III) in molten LiCl--KCl eutectic, 25:57420
MARTLEW, Clifford Keith, Series pairs of door sets, 25:60257
MARTRES, R. W., Polarographic determination of uranium in monazite sands, 25:57334
MARTYNCHUK, E. L., Variation in solubility of Ce, Pr, and Nd in Cr with temperature, 25:58237
MARTYNOV, A. M., Determination of cobalt in nickel preparations by a radiochemical method, 25:57356
MARUYAMA, Takashi, Whole-body absorbed dose from x and gamma rays, 25:58004
MARWICK, A. D., Low-angle scattering of energetic ions from an amorphous surface, 25:58689
MARX, D., Economic characteristics for fuel consumption in nuclear power stations, 25:60102
MASAKI, T., Leak rate test on reactor containment vessel for Mihama Power Station, 25:60000
MASHIBA, Tadashi, High-temperature electron plasma by slow mirror theta pinch, 25:59021
MASHININ, V. A., Detection of defects in butt welds with beta rays, 25:57700
MASHKOVA, E. S., Amorphization of crystals by ion bombardment and mechanisms of secondary processes, 25:59175

XUM

Energy dependence of secondary-electron emission in crystals, 25:59146
MASHOVETS, T. V., Donor--vacancy type complexes in germanium, 25:59133
MASI, G., Radiotoxicological analyses used at CNEN, 25:57347 (RT/PROT-(71)9)
MASIRONI, Roberto, Radioprotective action of Versene on gamma irradiated bacteriophages, 25:58032
MASLOV, A. I., Heating of a hot plasma created by an electron beam, 25:58972
MASLOWSKI, J., Green Bank sky survey in search of radio sources at 1400 MHz. I, 25:58531
MASON, Brian, Lunar rocks, 25:58678
MASON, P., Annihilation process p anti p $\to 2\pi^+2\pi^-$ at 2.5 GeV/c, 25:59271
MASPERI, L., Finite energy sum rules with $\pi\pi$ Veneziano amplitudes, 25:59450
MASSE, P., Solar longitude dependence of proton-event delay time, 25:58612
MASSMANN, P., Production of a very quiescent plasma in skipping magnetic fields, 25:59055
MASTEL, B., Microstructural analysis of neutron-irradiated titanium and rhenium, 25:58302
MATHER, D. S., Evaluation of average ν for ^{238}U, 25:59775 (AWRE-O-44/71)
MATHEWS, T., Rigidity dependence of Forbush decreases and 11-year variation in cosmic-ray intensity, 25:58823
MATHIE, J., Fast neutron irradiation of Al, Mg, and Cu, 25:58310
MATINYAN, S. G., Inclusive processes at large transferred momenta, 25:59444
MATOS, James E., Empirical analysis of the differences and sums of the kaon-nucleon angular distributions, 25:59477
MATOUS, K., Polarographic method of determining uranium in the presence of iron, 25:57321
MATSOUKAS, D. A., Simultaneous sudden frequency deviations and sudden enhancements of the total electron content of the ionosphere, 25:58901
MATSUDA, Satoshi, Hadron electrodynamics in the resonance model, 25:59386
MATSUI, Hiroshi, Radiometric survey at southern foot of Mt. Obora, Mie prefecture, 25:57566
MATSUMOTO, Akira, Separation factors in a europium chloride--samarium chloride--neodymium chloride--di(2-ethylhexyl)phosphoric acid system, 25:57543
MATSUOKA, Osamu, Final report of research project on plutonium hazards, 4/66--3/70, 25:57998 (NIRS-Pu-8)
Quark--molecule calculations, 25:59344
MATSUURA, Niro, Hot-atom chemistry of polyphosphates. IV, 25:57495
MATSUYAMA, Tsutomu, Electron microscopic study on acute thymic involution induced by polyoma virus infection, 25:58114
MATSUZAWA, Michio, Ionization of long-lived highly excited atoms by collision with molecules, 25:58750
MATTHEWS, J. A. J., Production of ρ-meson in $\pi N \to \rho^0 N$ charge exchange channels at 7 GeV/c, 25:59288
MATTHEWS, J. W., Detection of high explosives by capture gamma-ray techniques, 25:57866 (SC-RR-710450)
MATUR, H., Optics of the 75 cm hydrogen bubble chamber. I, 25:57826 (SJC-T-71-3)
MATVEEV, V. A., Quasipotential formalism for the two-particle system with spins 0 and $^1/_2$, 25:59422 (JINR-E2-6046)
Quasipotential theory of high-energy hadron scattering, 25:59442
MATVEEV, Yu. V., Plasma losses in high-current plasma configurations due to the inverse skin effects, 25:58967
Role of recurring discharge ignition in dynamic Z pinch, 25:59015
MATZKE, Hj., Ion bombardment study of behavior of rare gases in UO_2, 25:58413
Mobility and precipitation of rare gases in solids during annealing following ion bombardment, 25:58412
MAUGIN, G., Continuous medium deformation field in Minkowski space-time, 25:59562
MAURENZIG, P. R., Spin and parity of some excited states of ^{46}Sc, 25:59756
MAURIN, A. F., Making heating elements on the basis of zirconium dioxide for high-temperature furnaces, 25:58357
MAURIN, J. K., Preferential etching of ion-bombarded GaAs, 25:59141
MAURITZSON, I., Lifetime measurements in sd shell nuclei. VII, 25:59751
MAXIMOV, M., Donor--vacancy type complexes in germanium, 25:59133
MAY, H. P., Unfolding of experimental alpha-particle spectra for determination of the specific activity of alpha-emitting nuclides in bioassays in the milligram range, 25:57362
MAY, Leopold, Prog. rpt. on Moessbauer spectroscopy of biochemicals containing Fe, annual, 10/70--8/71, 25:60279 (NYO-3798-12)
MAYAUSKAS, Yu. S., Investigation of volatilization of MgO and ZrO_2 in oxidizing atmospheres, 25:58345
MAYER, P., Eclipsing variable IU Aurigae, 25:58475
MAYER, Ursula, Near-ultraviolet surface photometry of southern Milky Way, 25:58653
MAYERS, D. F., Relativistic atomic wave functions for open shells, 25:58800
MAYS, Charles W., Photon detector utilizing a well-type scintillation crystal, 25:57759
MAZETS, E. P., Cosmic gamma-ray measurements in range 0.3 to 3.7 MeV, 25:58831
Investigation of γ radiation by Cosmos-135, 25:58835
Investigation of variations of annihilation γ radiation by Cosmos-135, 25:58836
MAZEY, D. J., Void formation during ion irradiation of metals at elevated temperatures, 25:58320
Void formation in nickel, 316 steel, and nimonic PE16 during 20 MeV C^{++} irradiation, 25:58322
MAZIMOV, R. K., Damping of drift waves, 25:59103
MAZZIOTTI, Alexander, Error bounds to expectation values, 25:58810
MCCABE, Marie K., Mass motions in a flare spray, 25:58608
MCCALL, Richard C., Method for reading a thermoluminescent dosimeter, 25:57832
MCCAMMON, James R., Application of an indirect paired radio-iodine-labeled antibody technique to adenovirus-12 tumor serology, 25:57912
MCCARTHY, J. S., Nuclear charge distributions from electron scattering: barium and neodymium, 25:59793
MCCLUNG, R. W., Remote inspection of welded joints, 25:57680 (ORNL-TM-3561)
MCCONKEY, J. W., Absolute cross section for electron impact excitation of 3914-A N_2^+, 25:58726
MCCONKEY, K. N., Nuclear fuelling arrangement, 25:60252
MCCONNELL, Douglas H., Fatty acid transport into the brain, 25:60290 (UCLA-12-839)
MCCREA, W. H., Cosmical constant, 25:58661
MCCUNE, James E., Magnetohydrodynamic instabilities in weakly ionized, radiating plasma, 25:59066
MCDONALD, E. P., ATMX-500 rail car modification, 25:57705 (MLM-1812)
MCELROY, J. L., Summary report on analysis of semi-fluid condition in PG-6 phosphate glass solids container, 25:57702 (BNWL-B-112)
MCFEE, R. W., URCA process at high temperatures and densities, 25:58492
MCGREGOR, B. J., Prog. rpt. on fast reactor shielding, 8/71, 25:60055 (ORNL-TM-3573)
MCGUIRE, J. H., Use of NNγ data for NN phase shifts, 25:59520
MCINTYRE, P. A., Study of the reticuloendothelial system in hematological diseases, 25:58053
MCKELLAR, Bruce H. J., Parity violation in πN scattering, 25:59487
MCMATH, T. A., Some observations on germanium γ-ray spectrometers made from high purity p-type material, 25:57820
MCMILLAN, D. K., Decay of ^{80}As, 25:59749
Levels in ^{76}Se populated in β-decay of ^{76}As, 25:59748
MCNAMARA, Bernard J., Positional determination of NP 0532, 25:58537
MCNELIS, David N., Radionuclide studies with dairy cows following two Plowshare experiments, 25:57948 (SWRHL-85-r)
MCNELLY, M. J., Nuclear economics and change, 25:59920
MCNICHOLS, J. L., Improved fast neutron tolerance of GaAs JFET's operating in the hot electron range, 25:57905
MCREYNOLDS, John Frederick, Branching ratio $K \to e\nu/K \to \mu\nu$, 25:59256
MEAD, James F., Fatty acid transport into the brain, 25:60290 (UCLA-12-839)
MEANS, R. W., Evolution of turbulent electrostatic shocks, 25:59020
MEATS, R. J., Electrical breakdown of cold gaseous helium, 25:58950
MECKLENBRAUCK, W., Electronic excitation in fast collisions of Na with SO_2 and NO_2, 25:58749
MEDVEDEV, Yu. A., γ-ray induced scintillation, 25:59119
MEFFERD, Wayne S., Power meter for measurement of radiation, 25:57761
MEFOD'EVA, M. P., Heptavalent state of neptunium and plutonium, 25:57404
MEGY, J., Fast neutron reactor Phenix, 25:60039
MEIER, Homer K., Numerical integration methods of Vlasov equation, 25:59040
MEIERE, F. T., Low mass I = 0 S-wave $\pi\pi$ phase shift, 25:59306
MEILE, Louis J., Investigation of fluorine interactions with common glovebox construction materials, 25:57619 (RFP-1739)
MELAMED, Sh. G., Emission-spectral and radioactivation analysis of yttrium oxide with preliminary concentration of rare earth impurities by extraction chromatography, 25:57372
MELDE, D., Neutron dosimetry with radiation elements, 25:57776
MEL'NIK, B. A., Structure of gallium--indium alloys in the molten state, 25:58276
MEL'NIK, Yu. P., Adsorption of O on boundaries (100) of W, 25:58226
MELROSE, D. B., Degree of circular polarization of synchrotron radiation, 25:58547
MENDE, H., Liquid wastes of radiological institutes and isotope divisions, 25:57529
MENDEL, J. E., Summary report on analysis of semi-fluid condition in PG-6 phosphate glass solids container, 25:57702 (BNWL-B-112)

MENDEZ V., Rosa Ma., Variational calculation of ^{16}O in the α-particle model, 25:59726
MEN'KOV, A. A., Spectrophotometric determination of small amounts of scandium and yttrium in each others presence, 25:57318
MENOVSKY, A., Magnetic transition points in U_3Bi_4 and UGa_2, 25:59190
MENZEL, Donald H., Determination of coronal polarization, 25:58618
MERCINY, E., Dissociation constants of double complexes of type MeY_2H/sub n//sup (3-n)/$^-$, 25:57537
MERKELIJN, Jeannette K., Determination of luminosity function of radio galaxies at 400 and 2700 MHz, 25:58644
MERRILL, D., Experimental study of two-body and quasi-two-body reactions in K^-n interactions at 3 GeV/c, 25:59291
MERRITT, M. L., Ground motion predictions for Amchitka, 25:57602 (SC-RR-69-376)
MESCHINO, J. L., Canadian centrifugal pump industry, 25:57608 (70-CNA-658)
MESERVEY, R., Direct observation of spin-state mixing in superconductors, 25:58943
MESSERSCHMIDT, W., Periodic variations of cosmic radiation. II, 25:58825
METCALTE, Arthur G., Join exotic materials in seconds with continuous seem diffusion bonding, 25:58201
MEULEMAN, J., Recent developments of well-type detectors with less than 5 microns dead-layer, 25:57799
MEWHINNEY, James Albert, Fate of ^{252}Cf in rat, 25:57922
MEYER, H., Detector probe for encapsulated Ge(Li)'s directly immersed in liquid nitrogen, 25:57800
MEYER, J., Reconstruction of amplitudes for pion--nucleon scattering from experimental data, 25:59498
MEYER, K., Fuel consumption in reactor operation with varying duration of campaigns, 25:60216
MEYER, Ph., Galilean invariance in the infinite momentum frame and the parton model, 25:59431
MEYER, R. J., Feasibility study of the identification of fuel-cladding failures using sodium-soluble isotopic tags, 25:60083 (ANL-7785)
MEYEROTT, A. J., Helium-like line-emission coronal features, 25:58621
MEYER-SCHUETZMEISTER, L., Angular distributions for T/sub np/ = 1 and T/sub np/ = 0 transfers in (^{3}He,p) reactions, 25:59741
MEZHENNYI, Yu. O., Recrystallization and carbide phase formation processes in molybdenum base alloys, 25:58282
MICHAEL, Horst, Steam generator, particularly for pressurized water nuclear reactors, 25:60144
MICHAEL, W., π^+p elastic scattering data between 1820- and 2090-MeV cm energy, 25:59309
MICHALIK, J., Isotopic method for determining the efficiency of equipment for agglomerate production, 25:57659
MICHAUD, Andre Louis, Apparatus for determining the density of pulveralent materials in reservoir by means of a radioactive source and detector, 25:57872
MICHAUDON, A., Slow-neutron cross-sections of fissile nuclei, 25:59879
MICHEL, Claude, Measurement of parameters of Ce plasma, 25:58986
MICHELS, T. C., Evaluated nuclear cross section library, 25:59783 (UCRL-50400(Vol.4))
MIDDLTETON, R., Evidence for quartet states in ^{20}Ne, 25:59717
MIGGE, H., Knock-on of gas atoms into materials during irradiation in a gas atmosphere, 25:58334
MIHAI, I., Absolute measurement of ^{239}Pu fission cross-section for 2200 m/sec neutrons, 25:59777 (IFA-NR-33)
MIKA, Janusz, Fundamental eigenvalues of the linear transport equation, 25:59683
MIKAELIAN, K. O., Production of single W bosons in electron--positron colliding beams, 25:59383
MIKERINA, N. V., Solar wind parameter variation, magnetic activity, and electrons of the tail of magnetosphere and radiation zone, 25:58852 (LA-tr-71-69)
MIKHAILOV, G. I., Use of (p,γ) reaction to determine light-element content in thin surface layers, 25:57396
MIKHAILOV, N. V., Investigating the vibrocompacting of concrete mixes with the use of radioisotopes, 25:57869
MIKHAILOV, Yu. Ya., New phases in Sc--V--O system, 25:58401
MIKHAILOVA, A. I., Coprecipitation of radium with a prototype of the bone mineral calcium hydroxylapatite, 25:57418
MIKHAILOVA, O. A., Methods of determination of ^{137}Cs in objects of external environment, 25:57355
MIKHAILOVSKII, A. B., Ion-cyclotron drift instability in finite-β plasma, 25:59070
MIKHAILOVSKII, I. M., Evaporation of tungsten in strong electric fields as stimulated by nitrogen adsorption, 25:58227
MIKHALYUK, I. A., Trace element contents and natural radioactivity of foods in some districts of Kiev region, 25:57987
MIKHEL'SON, V. M., Recovery of chromosomes following ionizing radiation, 25:57970
MIKHNEVICH, V. V., Studies of atmosphere and ionosphere at times of unusual solar activity, 25:58893
MIKOLAJKOW, A., Double-detector scinticamera for visualization of cold nodules in bulky organs, 25:57763
MIKULIN, A. I., Solution of boundary-value problem for electron current in crossed fields, 25:58688
MILAZZO-COLLI, L., Pre-equilibrium emission in n,p and n,α reactions of CsI, 25:59826
MILGROM, Halina, Tumors of skin. XII, 25:58037
MILLER, A. E., Low-temperature magnetic behavior of several oxides of gadolinium, 25:59198
MILLER, D. H., Low mass I = 0 S-wave ππ phase shift, 25:59306
MILLER, D. R., Hexagonal networks of dislocations in α-Zr, 25:58288
MILLER, Guthrie, Inelastic electron scattering at large angles, 25:59242
MILLER, H. G., Effect of baryon resonance admixtures on elastic electron deuteron scattering, 25:59367
MILLER, J. M., Role of angular momentum and isobaric spin in tests of the independence hypothesis, 25:59830 (CU-1019-82)
MILLER, M. G., Hard-meson current algebra and the breakdown of partial conservation of axial-vector current, 25:59443
Hard-meson current-algebra calculation of γ--3π amplitude, 25:59382
MILLER, P. Rex, Electrical power systems for space: achievements and issues, 25:57671
MILLER, R. L., Metallography of the 300 series stainless steels exposed to high temperature sodium, 25:58174
MILLER, William Joseph, Many body final states from π^+d interactions near 3 GeV/c, 25:59282
MILYUKOVA, M. S., Behavior of various valence forms of Pu in acid--TBP system, 25:57357
MIMURA, Koji, Radiometric survey at southern foot of Mt. Obora, Mie prefecture, 25:57566
MINAMIKAWA, Toshiyuki, Compton scattering at high energies, 25:59340
MINARIK, E. V., S-wave threshold amplitudes of neutral pion photoproduction on nucleons and PCAC hypothesis, 25:59373
MINEEV, V. I., Bremsstrahlung from 7- to 10-MeV electrons in thin Si crystals, 25:59149
MIN'KO, I. F., ^{32}P transmission from plant to plant, 25:57950
MINYATOV, A. V., Cathode sheath in a distributed magnetoplasma, 25:59035
MIR, Khalid L., Lower bounds on total cross-sections for meson--baryon scattering and the modified Pomeranchuk theorem, 25:59474
MIRIC, Ivanka, Neutron dose determination with activation and biological detectors, 25:58019
MIRON, N. F., Direct observation of fluctuations of deuterium distribution in $(Nb_{0\ 33}Ti_{0\ 66})D_{0\ 33}$, 25:58278
MISCHKE, R. E., Experimental study of ω neutral decays, 25:59320
MISEREZ, A., Radioactivity of foodstuffs in 1969, 25:57989
Radioactivity of foodstuffs in 1970, 25:57988
MISHRA, M. M., Effect of rare elements on nitrification in soil suspension, 25:57401
MISHRA, U. C., Gamma spectrometric measurement of soil radioactivity, 25:57567
MISRA, R. K., Effect of magnetic activity on electron drifts in equatorial electrojet region, 25:58905
MISSBACH, M., Complex automation of nuclear power plants, 25:60048
MITCHELL, E. W. J., Radiation-induced defects in diamond, 25:59137
MITCHELL, P., Estimation and measurement of electron losses from avalanches in hydrogen, 25:59010
MITEL'MAN, M. G., Neutron detector, 25:57728
MITSEL'MAKHER, G. V., $\pi^+ \to e^+(\mu^+)\nu e^+e^-$ decays, 25:59412
Search for $\pi^+ \to e^+ +$ ν/sub e/ $+ e^+ + e^-$ decay, 25:59255 (BNL-tr-451)
Search for the decay $\mu^+ \to e^+ + e^+ + e^-$, 25:59254 (BNL-tr-449)
MITSONIAS, C. A., System for the production and study of bromine delayed neutron precursors from fission, 25:57504
MITSUK, V. E., Steady-state distribution of charged particles in the diffusion approach, 25:59048
MITSUTA, Hideo, High energy electron beam therapy, 25:58075
MITTLER, Arthur, Inelastic scattering of 8.0 to 9.0 MeV neutrons by ^{24}Mg, ^{27}Al, ^{28}Si, ^{31}P, and ^{32}S, 25:59770
MITYAEV, Yu. I., Advisability of operating nuclear power plants at a reduced power level before refueling, 25:60098
MIYAKAWA, Yasuhiro, Technological development in thermal and nuclear power generation in the 1970's, 25:59922
MIYAKE, Chie, Preparation of anhydrous uranium tetrachloride and measurements on its magnetic susceptibility, 25:57419
MIYAKE, Shin, Nuclear power as the source of energy in Japan, 25:59905
MIYAKE, Y., Recent fallout of radioactive dust in Japan, 25:57579
MIYATA, Takamoto, Energy levels of ^{142}Nd, 25:59821
MIYAZAKI, Taiichi, Radiotherapy of brain tumors, 25:58069
MIYAZAKI, Yukio, Pitch-angle distribution of fast electrons, 25:58904

XUM

MIZUMOTO, M., ^{208}Pb(γ,n)^{207}Pb reaction near threshold, 25:59778 (JAERI-Memo-4520)
MIZUNO, Mitsuhiko, Abnormal stopping power of proton and ion channeling, 25:59129
MOCHALOV, G. A., Structural peculiarities of polycrystalline molybdenum hardening during extrusion, 25:58277
MOCHON, Harry H. Jr., New England Power Exchange, 25:59907 (CONF-710606-15)
MODAN, B., Direct method of measuring total radiation dose to the brain using the Fricke dosimeter, 25:58012
MODDEMAN, W. E., K--LL Auger spectra of N_2, O_2, CO, NO, H_2O, and CO_2, 25:58736
MODE, V. Alan, Liquid chromatography. I, 25:57526 (UCRL-73190(Rev.1))
MODESITT, G. E., Bremsstrahlung power density: semiclassical calculations, 25:59045
MODJTEHEDZADEH, Mohammed, Multivariable expansion of scattering amplitudes, crossing symmetry of partial waves, and tests of various crossing symmetric models, 25:59619
MOEN, R. A., Translating elevated temperature material properties into rules for structural design, 25:60115 (HEDL-SA-164)
MOFFAT, P. H., Cygnus Loop at 1420 MHz, 25:58514
MOGIL'NER, A. I., Behavior of integral reactor characteristic K^+, 25:60227
MOHAN, H., /sup 80m/Br/I.T./^{80}Br reactions in inorganic bromide--hydrocarbon systems. I, 25:57494
MOHRI, Akihiro, Ohmic heating of plasma in Heliotron C magnetic field. I, 25:58963
MOINET, Claude, Preparation and control of the functioning of a mercury cathode cell working at an imposed potential, 25:60295 (UCRL-Trans-10548)
MOISAN, M., High-frequency resonant plasma, 25:59063 (NP-19031)
MOISEEV, D. N., Helium escape from irradiated borated materials with carbon--graphite matrix, 25:58378
MOISEEV, I. F., Comparison and analysis of the parameters of clinical whole-body spectrometers, 25:57823
MOISEEV, I. G., Radio intensity variations of 3C 273 at 2.3 and 8.15 mm, 25:58524
MOISEEV, S. S., Influence of longitudinal density gradient on the transformation and emission of transverse waves from a beam-plasma discharge, 25:59104
MOJOVIC, Ljubomir, Analysis of rentability of nuclear power plants, 25:60108
MOLCHANOV, V. A., Amorphization of crystals by ion bombardment and mechanisms of secondary processes, 25:59175
  Energy dependence of secondary-electron emission in crystals, 25:59146
MOLDABAEV, E. K., Study of large-area, flat scintillation detectors, 25:57828
MOLDOFSKY, P. J., In vivo measurement of plutonium and other very low energy emitters, 25:57770
MOLINARI, A., Isovector potential in ^{208}Pb from partial muon capture, 25:59808
MOLNAR, Peter, P-wave spectra from underground nuclear explosions, 25:57599
MOMOTA, H., Stochastic model of electron-cyclotron heating in a magnetic mirror, 25:58968
MONCEAU, P., Resistive behavior of the superconducting surface sheath of alloys, 25:58946
MONDAL, M. A. W., Effect of accelerator pulse shapes on neutron slowing down times, 25:60232
MONEN, H. P. M., Gross radioactivity in airborne dust, 25:57575 (RA-42)
MONSMA, William Brink, Baryon mass and electromagnetic interactions in O(4,2) x SU(3), 25:59548
MONTOJO, M. T., Effects of prior electrolysis on F-center growth in irradiated NaCl, 25:59164
MOONEY, Edward, Neutron activation studies of the Roanoke River system, 25:57395
MOORE, Carleton B., Distribution of total nitrogen in iron meteorites, 25:58423
MOORE, J. D., Some (n,p) cross-sections of ^{46}Ti, ^{47}Ti, and ^{48}Ti, 25:59755
MOORE, John H. Jr., Ion-impact energy-loss spectrum of oxygen, 25:58753
MOORE, R. W., Generalized Veneziano model for $\pi^-p \rightarrow K^0$ anti K^0n, 25:59492
MOORE, W. H., Highly excited states seen in reaction ^{12}C(^{16}O,p)^{27}Al, 25:59714
MOORTHY, P. N., Rate constants of reactions of photogenerated solvated electrons with monomers, 25:57475
MORAVCSIK, Michael J., Introduction to x-coefficients and a tabulation of their values, 25:59881
MOREAU, F., Effect of impurities on recovery of Al irradiated with fast neutrons, 25:58303
MOREAU, J. C., Fast neutron reactor Phenix, 25:60039
MORET, H., Assay of samples for nuclear measurements by physical methods, 25:59640 (CONF-711002-, pp 272-82)
MORFILL, G. E., Trajectory calculations in Williams and Mead geomagnetic-field model, 25:58861
MORGAN, Karl Z., Proper use of information on organ and body burdens of radioactive material, 25:58024 (CONF-711104-1)
MORGAN, Lesley A., Emission-line spectrum of Orion Nebula in range 4959 to 8665 A, 25:58513
MORGAN, Thomas Edward, Line blanketed model atmosphere for epsilon Virginis, 25:58484
MORGAN, Vernon, Heat engine plant, 25:60027
MORI, Koichi, Examples of stress analysis of structures by finite element method, 25:60142
MORI, Tomoyuki, Residual lesions following external high energy radiation therapy, 25:58074
MORIARITY, K. J. M., Generalized Veneziano model for $\pi^-p \rightarrow K^0$ anti K^0n, 25:59492
MORIKI, Toshio, Growth inhibition and radiosensitization of 5-fluorouracil in culture of HeLa cells, 25:58082
MORIMOTO, Nobuo, Crystallography of V/sub n/O/sub 2n-1/ (3 less than or equal to n less than or equal to 8), 25:58393
MORISHIMA, Atsuyoshi, Uranium dioxide fuel pin elongation behavior under irradiation, 25:58414
MORITA, Rikushi, Studies on liver function test with ^{131}I BSP monoiodide and scinticamera, 25:58042
MORITZ, J., Measurements of radiation-belt protons in energy range 0.25 to 1.65 MeV, 25:58890
MORIYAMA, Noboru, Conceptual design of the reactant flow loop for fissiochemical studies, 25:57613 (JAERI-Memo-4446)
MOROZOV, V. V., Electric properties of alloys of LaB_6 with transition metals. I, 25:59182
MORRISON, J., Evaluation of effective operators for configuration interaction, 25:58798
MORRISON, Nancy D., Photometry of three peculiar A-Type stars, 25:58454
MORROW, A. G., Experimental evaluation of a radioisotope-powered cardiac pacemaker, 25:57669
MORSE, R., Analysis of N*(1500) and N*(1700) baryon resonances produced via diffraction dissociation, 25:59307
MORSE, Robert I., Collinear collisions of atom and Morse oscillator, 25:58727
MORSY, Samira M., Assay efficiency and response for cylindrical scintillation crystals and large-area gas counters applied to whole-body counting, 25:57772
MORTON, Jane I., Detection of antinuclear antibodies in NAB and other mouse strains, 25:60285 (RLO-2226-T-3-8)
MOSCONI, B., Dispersive approach to ^{4}He(γ,d)d reaction, 25:59698
MOSENTHAL, William T., Scintillation scanning of liver cell adenoma, 25:58046
MOSHINSKY, M., The pseudo-atom: a soluble many-body problem, 25:58796
MOSSMAN, K. L., Actinomycin D in radioprotection and radiosensitization in Tetrahymena, 25:58091
MOTODA, Hiroshi, Optimal control rod programming of light water reactors in equilibrium fuel cycle, 25:60101
MOTOTAKE, Sakudo, Real time dose distribution display by digital computer, 25:58078
MOTOV, D. L., Extraction of hafnium with cyclohexanone solution of thiocyanic acid, 25:57533
MOTTET, P., Development of properties of nuclear graphite obtained by a mixture of cokes, 25:58366 (CEA-CONF-1820)
MOTUZKOV, I. N., Trace element contents and natural radioactivity of foods in some districts of Kiev region, 25:57987
MOULIN, D., Plasma heating at the lower-hybrid resonance, 25:58960 (CEA-CONF-1831)
MUEHLHAEUSER, O., Hydraulic control rods. Ideas and investigations for the development of fully hydraulically operated and controlled control and shutdown systems for water and steam cooled nuclear reactors, 25:60047
MUELLER, D., Vacuum-uv emission of high-density plasma generated in wall-stabilized arc, 25:59006
MUELLER, K. F., Texture parameters by optical and electron-microscope pictures of WC-, Co-, TiC-, and TaC-alloys, 25:58403
MUELLER, R. A., Change of interpretation of the intermediate heat exchanger for the sodium cooled reactor using ferritic steel design, 25:57614 (KFK-1387)
  Inherent properties of the various primary circuit designs for sodium-cooled reactors, 25:60060 (EURFNR-904)
MUELLER-ROOS, J., Current pulse shapes of semiconductor detectors, measured with an averaging technique, 25:57737
MUIRHEAD, H., Annihilation process p anti p $\rightarrow 2\pi^+2\pi^-$ at 2.5 GeV/c, 25:59271
MUKAIBO, T., Crystal structure of graphite bromine lamellar compounds, 25:58404
MUKHA, I. M., Effect of heating by glow discharge on the physico-chemical surface condition of solid alloys, 25:58233
MUKHAILOV, S. M., Thermoemissive properties of a spherical monocrystal of tantalum, 25:59177
MULCAHEY, T. P., Development of an in-core permanent-magnet probe-type sodium flowsensor for operation in the Fast Flux Test Facility (FFTF), 25:60183
MUMMA, M. J., Excitation of vuv emission features by electron impact on molecular gases. I, 25:58728
MUNECHIKA, Hirotugu, Radiosensitivity of the radiation induced aminopterin resistant yeast cells, 25:57927
MUNRO, Richard H., Electron densities derived from line intensity ratios: beryllium isoelectronic sequence, 25:58599

MURAD, Edmond, Collisions between low-energy N^+ and N_2, 25:58735
MURAKAMI, Eisuke, Effect of x-ray or gamma-ray irradiation on rat tibia, 25:58102
MURATA, Hideo, High-temperature electron plasma by slow mirror theta pinch, 25:59021
MURAYAMA, Akihiro, Correspondnce between the three-triplet model and the quartet model in nonleptonic hyperon decays, 25:59423
MURDIN, P., Optical identification of Cygnus X-1, 25:58554
MURPHY, Walter T., Radiation therapy of skin carcinoma, 25:58068
MURRELL, Michael David, Nuclear reactor control system, 25:60054
MURRMANN, R. P., Determination of trace elements in soils and clay minerals by resonance neutron activation analysis, 25:57375
MURTHY, C. S., Dissociation equilibrium of some diatomic molecules in delta Cephei, 25:58479
MURTHY, M. S., 60° sector mass spectrometer for gas analysis, 25:57890
MUSHER, J. I., Spatial eigenfunctions of the spin-independent many-electron Hamiltonian, 25:58791
MUSHINSKII, A. A., Experimental determination of the electron concentration and temperature of an argon plasma jet by means of lasers, 25:58987
MUSIKAS, C., Plutonium(V) peroxide, 25:57400
MUTO, Kiyoshi, Earthquake response analysis of nuclear power plant, 25:57598
MUTSURO, Naoshi, Isospin effect in ^{31}P(γ,n) reaction, 25:59765
MUZGIN, V. N., Spectrographic method for determining main components in alloys based on cobalt, 25:57313
MYASNIKOV, A. M., Study of hardening during fatigue of various pure metals, 25:58223
MYASOEDOV, B. F., Isolation of berkelium on a zirconium phosphate--silicate sorbent, 25:57530
MYERS, David S., Plea for consistent lung burden criteria for insoluble alpha emitting isotopes, 25:58001 (UCRL-73388)
MYNATT, F. R., Experimental investigation of neutron streaming through the grid-plate shield of the fast flux test facility, 25:60158 (ORNL-TM-3514)
  Prog. rpt. on fast reactor shielding, 8/71, 25:60055 (ORNL-TM-3573)
MYSEV, I. P., Maintenance of electron equilibrium in the calibration of dosimeters in gamma radiation beams, 25:57860
  Sensitive element for radiothermoluminescent dosimeters for gamma and neutron radiations, 25:57849
MYSLEK, B., Relative K-capture probability in unique first-forbidden decay of ^{145}Sm, 25:59799
MYTAREVA, L. V., Adenine nucleoproteides in white rats suffering from radiation sickness, 25:57936

N

NACHTMANN, O., Coulomb corrections to Adler's PCAC test in nuclei, 25:59406
NADACKAPADAM, X., Operant behavior of pre- and post-pubertal rats irradiated with ^{131}I, 25:58100
NADKARNI, R. A., Substoichiometric determination of selenium by neutron activation analysis, 25:57380
NADYKTO, B. T., Effects of nuclear radiation on the activity of a palladium catalyst for the hydrogenation of butynediol, 25:57448
NAEGELE, H. P., Investigation of ^{6}Li(d Vector,α)^{4}He reaction, 25:59737
NAGAI, Y. E., Explanation for nonleptonic decays of hyperons, 25:59420
NAGASAWA, Noichi, Crystal growth of V/sub n/O/sub 2n-1/ (3 less than or equal to n less than or equal to 8), 25:58369
NAGASE, Tetsuya, Radiotherapy of lung cancer, 25:58137
NAGATA, N., Basal dislocation interactions with a forest of non basal dislocations in zinc, 25:60267 (CALT-767-P-3-18)
  Experimental determination of the line energy of a basal screw dislocation in zinc, 25:60266 (CALT-767-P-3-17)
NAGATA, Sinobu, Reaction matrix theory for cluster states in light nuclei. II, 25:59724
NAGATANI, K., Reaction ^{12}C(^{14}N,^{6}Li)^{20}Ne and structure of upper $K = 0^+$ bands, 25:59743
NAGATO, Kotaro, Examples of stress analysis of structures by finite element method, 25:60142
NAGAYA, Yutaka, Strontium concentrations in water of north Pacific and seas of Japan, 25:57310
NAGEL, S., Safety rod movement during scram in ZfK Rossendorf research reactor, 25:60165
NAGIB, M. M., Combined helium and steam cycle for nuclear power plants, 25:60139
NAGY, A. F., Dynamical behavior of thermal protons in the midlatitude ionosphere and magnetosphere, 25:58867
NAGY, Arpad, ^{252}Cf neutron source, 25:57661
NAIR, S. C. K., Shape mixing in ^{24}Ne, 25:59728
NAKAHARA, Kazuo, Study of nuclei by electron scattering, 25:59736
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NAKAJIMA, K., Optics of the 75 cm hydrogen bubble chamber. I, 25:57826 (SJC-T-71-3)
NAKAJIMA, T., New thermoluminescence dosimeter of high sensitivity using a magnesium silicate phosphor, 25:57841
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  Wavelength dependence of interstellar polarization, 25:58488
NAPIER, W. M., Intrinsic variations of interstellar extinction laws, 25:58489
NARITA, Kiichi, Effects of Mn, Si, Cr, and Ni on reaction of solution and precipitation of Nb nitride in Fe austenite, 25:58268
NARLIKAR, J. V., Nature of mass, 25:58667
  Time asymmetry in electrodynamics and cosmology, 25:58671
NARUKI, Kaoru, Vibratory compaction of UO_2. II, 25:58364
NARUMI, Hajime, Cascade process in mesic atoms, 25:58724
NASCUTIU, T., Absolute measurement of ^{239}Pu fission cross-section for 2200 m/sec neutrons, 25:59777 (IFA-NR-33)
NASSIKAS, John N., Public participation in locating facilities, 25:60004
NAUDET, Robert, Handling grip, 25:60259
NAUMENKO, V. Ya., Electro-erosion resistance of refractory carbides within corresponding ranges of homogeneity, 25:58356
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NECHIPORENKO, E. P., Study of the gas evolution and mechanical properties of molybdenum wire, 25:58221
NEDAVNII, O. I., Two-channel defectoscope, 25:57889
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NEEDES, C. R. S., Calculation of the equilibrium distribution of metal-ion complexes in multicomponent aqueous systems, 25:57398 (NIM-1093)
  Three-dimensional predominant-area and solubility diagrams for uranyl carbonate and uranyl sulphate systems at 25°C, 25:57399 (NIM-1144)
NEFF, R., Investigation of ^{6}Li(d Vector,α)^{4}He reaction, 25:59737
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NEKRASOV, G. K., Search for the decay $\mu^+ \to e^+ + e^+ + e^-$, 25:59254 (BNL-tr-449)
NEKRASOV, K. G., Search for $\pi^+ \to e^+ + \nu$/sub e/ $+ e^+ + e^-$ decay, 25:59255 (BNL-tr-451)
NELSON, Paul Jr., Optimal strategies in reactor system economics, 25:60103
NELSON, R. S., Void formation during ion irradiation of metals at elevated temperatures, 25:58320
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NEMTSEVA, L. S., Differences in radiation-induced lesions of chromosomes of embryonic meristem of Crepis capillaris seeds, 25:57968
NESTEROV, A. A., Luminescence of irradiated β-SiC, 25:59139
NEUBERT, Theodore J., F-aggregate centers in Na chloride. I, 25:59152
NEUFELD, Lorin Wesley, Analysis of the arc and spark spectrum of scandium, 25:58701
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NEUMANN, M. J., Performance of foil supported electrode system and plans for improvement, 25:57750
NEWING, R. A., Note on neutrino-gravitational fields with positive energy density, 25:59589
NEWMAN, Ezra T., Trapped surfaces and the development of singularities, 25:59602
NEWTON, C. S., Scattering of charged particles by single crystals. I, 25:59157
NEWTON, G. J., Separation of multicurie quantities of ^{90}Y from ^{90}Sr, 25:57352
NEZHNOVA, T. I., Photometric determination of niobium with magneson, 25:57315
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by deuterium, 25:57920
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NGUYEN VAN HIEU, Asymptotical properties of K/sub L/^{0} + p $\rightarrow$ K/sub S/^{0} + p amplitude, 25:59494
NGYUEN, Tak An., Production and decay of compound nuclei in high-energy heavy ion reactions, 25:59779 (JINR-P7-5912)
NIAS, A. H. W., Influence of recovery from sublethal damage on the response of cells to protracted irradiation at low dose-rate, 25:58088
NICHOLLS, J. E., ESR studies of intrinsic and impurity defects in silica and germania, 25:59174
NICHOLS, Ronald William, Improvements in or relating to nuclear reactors, 25:60074
NICOLAS, M., Plasma confinement in the DECA II B circularized magnetic well, 25:58958 (CEA-CONF-1807)
NICOLETOPOULOS, P., Regge cuts and eikonal approximation in field theory. II, 25:59579
NIEBUHR, H., Bibliographies in nuclear science and technology. Section 14, 25:57368 (AED-C-14-5)
NIEDZIELSKI, J., Gamma radiolysis of gaseous ethylene in the presence of isobutylene, 25:57474
NIELSEN, H., Information on low-energy $\pi\pi$ interaction from elastic pion--nucleon phase shifts, 25:59463
Invariant amplitudes of pion--nucleon scattering in unphysical region, 25:59481
NIHOUL, J., Recovery of rhenium following low-temperature alpha-particle irradiation, 25:59142
NIKITIN, E. E., Angular distribution of products of reactions proceeding through formation of a long-lived complex, 25:58773
NIKITIN, Yu. P., Angular and momentum distributions of μ^+ mesons from W^+-boson decay in reaction ν/sub μ/ + Z $\rightarrow$ μ^- + Z + W^+, 25:59413
Angular and momentum distributions of μ^- mesons in reaction ν + Z $\rightarrow$ μ^- + W^+ + Z, 25:59414
NIKOLAEV, V. M., Separation of actinides and lanthanides on Zr phosphate. II, 25:57551
Separation of actinides and lanthanides on Zr phosphate. I, 25:57550
NIKOLAEV, V. S., Electron loss and capture cross sections for multiply charged ions in solid matter, 25:58695
NIKOLINA, A. A., Angular distribution of the low energy neutrons from the nuclear μ-capture in sulfur and calcium, 25:59738 (JINR-P1-6029)
NIKOLOV, A., Classification and mass formulas for mesons in ladder U(6,6) symmetry, 25:59546
NIKOL'SKII, G. M., Profiles of coronal lines based on large coronograph observations, 25:58572
NIKOL'SKII, S. I., Complex investigation of extensive air-shower core with energy greater than or equal to 10^{15} eV, 25:59249
NIKONOV, V. N., Express determination of yttrium in rare earth concentrates by the method of activation with fast neutrons, 25:57382
NIKULIN, M. G., Dynamic stabilization of thin plasma filaments, 25:59071
NIKULINA, I. N., Determination of cerium in refractory alloys with use of chromatographic separation, 25:57338
NIMS, John B. Jr., Fuel systems for nuclear reactors, 25:60255
NIMS, Leslie F., Membranes, material transfer, and ideal tracer theory, 25:60261 (BNL-50299)
NISHANOV, P. Kh., Neutron activation determination of cobalt by nondestructive means, 25:57386
NISHIHARA, Hideaki, Measurement of temperature fluctuations in a natural convection water loop, 25:60242
NISHIJIMA, Kazuhiko, Nonleptonic decays of neutral K mesons and Lee--Sugawara sum rule, 25:59396
NISHIKAWA, Kiyoshi, Estimation of coefficient of luminescence in organic scintillator by using digital computer, 25:57753
NISHIKAWA, M., γ-radiolysis of gaseous carbon dioxide at high densities, 25:57461
NISHIMURA, G. S., Classification of the indium--zinc eutectic, 25:58286
NISHIMURA, Keiichi, Polynomial expansion method for problems involving a relativistic Maxwellian distribution, 25:59053
NISHIWAKI, Akira, Correlations between sudden phase anomalies in very long waves and bursts of solar x rays, 25:58888
NISTLER, W., Neutron--proton and neutron--carbon scattering amplitudes, 25:59696
NIX, J. R., Finite-difference solution of axially symmetric nuclear single-particle potentials, 25:59839 (LA-4735)
NOLTINGK, B. E., Some uses of radioactive isotopes in measurements on turbines, 25:57663
NOMURA, Koichi, Study of photo-nuclear reaction by means of residual nucleus method, 25:59815
NONAKA, Itaru, Alpha-ray thickness gage. II, 25:57864 (INS-TL-112)
NOONAN, Thomas W., Mean ratio of mass to the three-halves power of luminosity for elliptical and lenticular galaxies, 25:58635
NORBECK, E., Production of three ^{4}He nuclei by direct interaction of ^{6}Li with ^{6}Li, 25:59718
NORETS, T. A., Comparative behavior of ^{89}Sr and ^{140}Ba in skin, 25:57917
NORRIS, D. I. R., Conference on voids formed by irradiation of reactor materials, Reading, Eng., 3/71, 25:58304
Simulation of fast reactor irradiation effects in the high voltage electron microscope, 25:58326
NORTHOVER, E. W., New high-stability nickel alloy thermocouple, 25:57876
NOSKOV, M. M., Optical properties of Gd, Sm, and Dy in spectral range 1.13 to 3.96 eV, 25:59187
NOVAK, V. J. A., Effect of x irradiation of the head on neurosecretory cells in Gryllus domesticus L, 25:58095
NOVARO, O., The pseudo-atom: a soluble many-body problem, 25:58796
NOVGORODOVA, A. F., Fast thermochemical methods of separation of radioactive elements. I, 25:57480 (JINR-P6-5955)
NOVICK, R., Oscillation in optical and x-ray flux from Scorpius X-1, 25:58535
Oscillations in x-ray flux from Scorpius X-1, 25:58536
NOVIKOV, A. I., Separation of Ru, Rh, and Pd by coprecipitation with ferric hydroxide, 25:57552
NOVIKOV, I. I., Study of the molybdenum--zirconium--carbon system, 25:58273
NOVIKOV, S. R., Formation and annealing of radiation defects in Ge, 25:59159
NOVIKOV, V. T., Activation detector, 25:57729
NOVOTNA, P., Absolute activity measurement of ^{3}H, 25:57505
NOYES, Clyde R., On-line, digital data handling and optimal control investigations at the Missouri University Research Reactor, 25:60185
NOZAWA, Masao, Development of experimental multi-purpose high temperature gas-cooled reactor, 25:60202
NOZAWA, Shunya, Development of experimental multi-purpose high temperature gas-cooled reactor, 25:60202
NUGENT, L. J., Electron-transfer and f $\rightarrow$ d absorption bands of some lanthanide and actinide complexes and standard (III--IV) oxidation potentials for each member of lanthanide and actinide series, 25:57437
NULMAN, R., Multiparticle production model with charge conservation, 25:59512
NUNN, A. D., ^{52}Fe: improving its recovery from cyclotron targets, 25:57486
NUSSENZVEIG, H. M., Applications of Regge poles to short-wavelength scattering, 25:59615
NUTTALL, J., Asymptotic form of the three-particle scattering wavefunction for free incident particles, 25:59624
NUTTER, P. H., Effect of stress during irradiation on void formation in nickel, 25:58308
NUZHDIN, N. I., Radiation resistance in plants, 25:57969

O

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OBINATA, Sumiko, Stability study of a PWR nuclear power station connected to an electric power system, 25:60105
OBOSHI, Shoichi, Tumor-host relation in cancer radiotherapy, 25:58072
O'BRIEN, James E., Interferometric measurements of 142 solar wavelengths, 25:58595
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OBUKHOV, V. K., Temperature effect in 20 to 250°C range for certain, strictly regular, heterogeneous, U--H_2O critical assemblies, 25:60161
OCHSENFELD, W., Aqueous reprocessing of fast breeder fuel elements, 25:57518 (EURFNR-888)
ODA, E., Radiation induced ionic polymerization, 25:57450 (ORO-3667-1)
ODABASI, Halis, Topics in modern physics, 25:58682
ODISHARIYA, G. A., Initial phases in condensation of Zr on W, 25:58229
O'DONNELL, F. R., Preparation of self-supporting, metallic foils of isotopic chromium, 25:59633 (CONF-711002-, pp 39-46)
Tritium-containing targets for high-yield neutron generators, 25:59670 (CONF-711002-, pp 166-80)
O'DONOVAN, P. J., Polarization in $0^-1/2^+ \rightarrow 0^-1/2^+$ charge and hypercharge exchange reactions at intermediate energies, 25:59503
OEZER, A. M., ESR studies of intrinsic and impurity defects in silica and germania, 25:59174
OFFUTT, G. F., First product denitration campaign with enriched uranium at ICPP, 25:57397 (IN-1475)
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OGANESIAN, Yu. Ts., Production and decay of compound nuclei in high-energy heavy ion reactions, 25:59779 (JINR-P7-5912)
OGATA, Noboru, Fundamental study on the collection of uranium in seawater, 25:57337
OGAWA, Shuzo, Semi-leptonic process, 25:59394
OGAWA, Yuichi, Optimal power change of a reactor having internal feedback, 25:60241
OGILVIE, K. W., Relationship of interplanetary parameters and occurrence of magnetospheric substorms, 25:58856
OGORODNIK, S. S., Investigation of the calibration characteristics of a radiation thermodiverter in high-intensity fields of ionizing radiations, 25:57879
Possibility of variations in unit pulses of radiative

heat, 25:57878
OGREN, H., High-energy electron--positron elastic scattering, 25:59250
Mulitparticle production from e^+e^- interactions as high energy, 25:59251
OGURTSOV, G. N., Interpretation of the energy spectrum of electrons produced in atomic collisions, 25:58733
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OHNISHI, Haruyuki, High-temperature electron plasma by slow mirror theta pinch, 25:59021
OHNO, Tadao, Experimental fast reactor Joyo, 25:60174
Experimental fast reactor Joyo, 25:60176
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OKAWA, Tomohiko, Radiotherapy of brain tumors, 25:58069
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Optimization study of fast reactors, 25:60217
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Heterogeneous dislocations in GaAs, 25:60291 (UCRL-20525)
OSIPOV, V. N., Electromigration of ions of ^{22}Na, ^{42}K, ^{86}Rb, and ^{134}Cs in molten chlorides, 25:57439
OSIPOVA, I. N., Effect of γ-irradiated fresh fish on rats, 25:58162
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OSKAM, H. J., Ion production and loss processes in helium--nitrogen mixtures, 25:59014
Production and loss of N_2^+, Ne^+, and Ne_2^+ during decay period of plasmas produced in Ne--N mixtures, 25:59019
OSLAND, P., Elastic and single-charge-exchange scattering of pions by carbon nuclei, 25:59523
OSMACHKIN, B. P., Investigating the vibrocompacting of concrete mixes with the use of radioisotopes, 25:57869
OSMACHKIN, V. S., Heat exchange crisis during movement of boiling water along fuel rod banks, 25:57638 (IAE-2014)
OSTERBROCK, D. E., Line and continuum problems in gaseous nebulae, 25:58473
OSTERTAG, H., Operating experience and results obtained with TRIGA research reactor, 25:60173
OTANI, Shiro, Real time dose distribution display by digital computer, 25:58078
OTTAVIANI, P. L., Analysis of 14.1 MeV neutron scattering from ^{11}B, 25:59720
OTTEMANN, J., Morphology and chemistry of magnetite layers, 25:58165 (AEC-tr-7237)
OTWAY, Harry J., Economic vs biological risk as reactor design criteria, 25:60003
OVCHINNIKOV, A. K., New radiometric apparatus for prospecting radioactive ores, 25:57867
OVCHINNIKOVA, M. Ya., Theory of anomaly of differential scattering cross sections for high-energy atoms, 25:58767
OYAMADA, Masayuki, Study of nuclei by electron scattering, 25:59736
OZERNOI, L. M., Possibility of a pulsed mass outflow from a rotating magnetic star, 25:58431
OZHIGOV, L. S., Recrystallization of copper reinforced with tungsten, 25:58285

P

PACKAN, N. H., Effect of neutron dose on void formation in high purity aluminum, 25:58311
PADILLA, Andrew Jr., Analysis of mechanical work energy for LMFBR maximum accidents, 25:60121
PAETZ, Peter, Kinetics of hydrogen engassing of delta--zirconium hydride, 25:58373
Lattice parameter and density of zirconium hydride phase, 25:58402
PAGELS, Heinz, Breaking Nambu--Goldstone chiral symmetries, 25:59541
PAGES, L., Dosimetric characteristics of a Teflon--carbon mixture for the construction of cavity chambers for measurement of absorbed dose in the air, 25:57861
PAGIOLA, E., Experimental test of semi-local duality in $K^-p \rightarrow$ anti K^0n backward scattering, 25:59482
PAIGE, B. E., Process chemistry for burner product from graphite fuels containing niobium, 25:57519 (IN-1484)
PAIK, Han Won, Study of intermediate angle $\pi^{+-}p$ elastic scattering from 3.0 to 5.0 GeV/c, 25:59285
PAIK, S. F., Recent advances in gas-discharge duplexers, 25:57902
PAINTER, R. B., Repair of DNA in mammalian cells, 25:57943
PAJERSKI, David Walter, Trapped surfaces and the development of singularities, 25:5[illegible]502
PAK, A. M., Effects of nuclear radiation on the activity of a palladium catalyst for the hydrogenation of butynediol, 25:57448
PAKHOMOV, L. P., Microwave absorption by a plasma at the upper hybrid frequency, 25:59091
PALAGYI, S., Possibilities of rapid separation of radioiodide, radioiodate, and radioperiodate, 25:57559
PALER, K., Application of dual diffractive model to reaction $\pi^+d \rightarrow d\pi^+\pi^+\pi^-$ at 13 GeV/c, 25:59480
PALMER, I. D., Direct observation of cosmic-ray energy losses, 25:58590
PALMIERI, A., Measurement of the effect of twisted tapes on the forced-convection heat transfer and burnout in heat exchangers, 25:57643
PALMS, John M., Eye tumor identification tests using semiconductor detectors, 25:58064
Medical problems in eye tumor identification, 25:58063
PAL'SHIN, E. S., Extraction of protactinium and its analogs from solutions of oxalic and tartaric acids with tributylamine, 25:57546
PALUMBO, D., Effect of zirconium additions on the creep strength of aluminum--copper alloys, 25:58239
PALUMBO, F., Nuclear center of mass coordinate in Bloch--Horowitz theory, 25:59832 (JINR-E4-5890)
PALUZELLE, R., Pyrolytic carbon infiltration studies, 25:58352 (Y-DA-2123(Rev.1))

PAN, V. M., Influence of yttrium on the phase composition of vanadium--gallium alloys, 25:58289
PANASYUK, I. S., Neutron detector, 25:57728
PANDE, M. C., Dependence of molecular dissociation equilibrium on magnetic field strength in sunspots, 25:58589
  Dissociation equilibrium of some diatomic molecules in delta Cephei, 25:58479
  Effect of scattered light on the facula-to-photosphere contrast, 25:58587
PANDE, U. S., Gamma transitions in ^{160}Dy, 25:59819
PANDHARIPANDE, V. R., Dense neutron matter with realistic interactions, 25:59866
PANDYA, S. P., Shape mixing in ^{24}Ne, 25:59728
PANKRATOV, V. G., Cathode sheath in a distributed magnetoplasma, 25:59035
PAPADAKIS, E. P., Nuclear reactor applications of new ultrasonic transducers, 25:57898
PAPADOPOULOS, G. J., Exact propagator, 25:59349
PAPADOPOULOS, K., High-Mach-number turbulent magnetosonic shocks, 25:59044
PAPAGEORGIOU, S., Dual + Pomeron analysis of $K^{+-}p + K^{+-}\pi^0p$, 25:59490
PAPAGIANNIS, M. D., Simultaneous sudden frequency deviations and sudden enhancements of the total electron content of the ionosphere, 25:58901
PAPAMARCOS, John, Spinning discs: a better way to cool pond water, 25:60023
PAPAPETROU, Achille, Some remarks on the newman-penrose formalism, 25:59593
  Supplementary trivial equations in Penrose-Newman formalism, 25:59586
PAPINI, G., Binding energy of the deuteron, 25:59526
  Binding energy of the singlet deuteron, 25:59518
PARADELLIS, T., Decay of ^{68}As, 25:59747
PARDEE, William Joseph, Quantum-electrodynamic model for production amplitudes at infinite momentum, 25:59345
PARETZKE, H., Applicability of track detectors in neutron dosimetry, 25:57855
PARIMUCHA, F., Possibilities of spectrophotometric determination of U in washing, processing, and waste waters from nuclear power plants, 25:57343
PARISI, G., Angular correlations of the decay products of two heavy leptons, 25:59390
  Observations on production of hadrons by means of Landau--Lifshitz process, 25:59334 (LNF-71/14)
PARISI, J., Study of vertices $\pi^0\gamma\gamma$, eta$\gamma\gamma$, and eta'$\gamma\gamma$ with one highly virtual photon, 25:59389
  Study of vertices $\pi^0\gamma\gamma$, eta$\gamma\gamma$, and eta'$\gamma\gamma$ with almost real photons, 25:59253
PARK, In Yong, Parameter sensitivity of the reactor control system by means of the root locus method, 25:60219
  Studies on the heat transfer dynamic analysis and the stability of TRIGA Mark-II reactor, 25:60164
PARK, Je Baik, Parameter sensitivity of the reactor control system by means of the root locus method, 25:60219
PARK, Robert T., Complex Regge poles in πN backward scattering, 25:59495
PARK, Yong Chip, Studies on the heat transfer dynamic analysis and the stability of TRIGA Mark-II reactor, 25:60164
PARKER, E. N., Recent developments in theory of solar wind, 25:58894
PARKER, G. W., Size classification of submicron particles by a low-pressure cascade impactor, 25:57573 (ORNL-4226)
PARKER, R. P., Experience with semiconductor detectors as dosimeters in a clinical environment, 25:57743
PARKINSON, J. H., New observations of satellite lines in the solar x-ray spectrum, 25:58583
PARKS, P. B., Static and pulsed reactivity measurements on large ^{235}U fuel forms in water, 25:60212
PARRATT, N. J., Silicon carbide as a reinforcement, 25:58361
PARSHIKOV, V. G., Study of the molybdenum--zirconium--carbon system, 25:58273
PARSHUTIN, V. V., Anodic dissolution of hard alloys of VK type in alkali--nitrate electrolytes, 25:58177
PARSONS, J. R., Damaged regions in neutron-irradiated and ion-bombarded Ge and Si, 25:59140
PARTAIN, C. Leon, On-line, digital data handling and optimal control investigations at the Missouri University Research Reactor, 25:60185
PARTAIN, William Lee Jr., Interactions of radiant energy with small particles in hot, high pressure gases, 25:57641
PARZHITSKII, S., Determination of the neutron--neutron scattering length from a kinematically complete experiment with the reaction ^{3}H(t,n^{4}He)n, 25:59506 (JINR-E15-5905)
PASACHOFF, Jay M., Absolute intensity calibrations of solar K-line profiles, 25:58596
PASCHKOWSKY, A. I., Mechanical properties of Mo and W single crystals, 25:58257
PASCULESCU, Gh., Effect of low x-ray doses on central nervous system, 25:58098
PASK, C., Charge asymmetric potentials and the three nucleon system, 25:59701
PASK, Colin, Tamagaki and Hamada--Johnston potentials and elastic electron--deuteron scattering, 25:59335
PASTUSHENKO-STRELETS, N. A., Radiation resistance in plants, 25:57969
PATANE, Michelangelo, Storage of radioactive substances, 25:57719
PATARAYA, A. D., Nonstationary weakly nonlinear waves in multicomponent cold plasma, 25:59090
PATCH, D. R., Nuclear reactor applications of new ultrasonic transducers, 25:57898
PATCHETT, B., Wavelength shifts of intensity minima in Type-I supernova spectra, 25:58501
PATE, B. D., Decay of ^{80}As, 25:59749
  Levels in ^{76}Se populated in β-decay of ^{76}As, 25:59748
PATEL, R. J., Effects of irradiation (high energy β rays) on cladophorales. I, 25:58153
PATET, J., Cellular ultrastructure and mitotic index of lymphocytes of leukemia during treatment by irradiation, 25:58131 (CEA-CONF-1768)
PATRICK, G., Liquid scintillation counting of ^{45}Ca in soft tissues, 25:57361
PATRUSHEV, B. I., Plasma heating at the electron cyclotron frequency, 25:58971
PATTERSON, R. W., Stretch-out in power plant schedules, 25:59893
PATTON, James A., Multicrystal tomographic scanner for mapping thin cross section of radioactivity in an organ of the human body, 25:57754
PATTON, Waldo A., ISIS: program for computerized fission data analysis, 25:59773 (AD-721481)
PAUL, P., Symmetry energy for collective dipole excitation, 25:59742
PAULIKAS, G. A., Patterns and sources of high-latitude particle precipitation, 25:58896
PAULUS, J. M., Formation of iodides in solid butane irradiated by I$^+$ ions, 25:57499
PAULY, H., Total effective cross sections for scattering of He, HD, and D$_2$ by several molecules, 25:58782
  Total effective scattering cross sections of HD-inert gas systems in thermal energy region, 25:58781
PAVELESCU, M., Discrete SN numerical method in neutron transport theory, 25:59675
PAZOISKI, S. V., Theory of structural corrections in pair conversion coefficients in M1 transitions of nuclei, 25:59861
PEABODY, C. O., Development of thermoluminescence dosimetry systems, 25:57840
PEARCE, J. A., Four suspected spectroscopic binaries in Pleiades, 25:58458
PEERY, Benjamin F. Jr., Technetium in Mira variable RZ Pegasi, 25:58459
PEGEL, V. A., Action of gamma radiation on the adrenal cortex and thyroid gland in the rat, 25:58107
  Radon irradiation of rat tissue and organs, 25:57932
PEHL, R. H., Pulsed feedback techniques for semiconductor detector radiation spectrometers, 25:57812
PEIERLS, R. F., Scattering of unstable particles, 25:59616
PEKAREK, S., Low-pressure toroidal glow discharge in the radial magnetic field, 25:59002
PEKER, L. K., Two-proton and two-neutron radioactive decay from many-particle isomeric states of nuclei, 25:59740
PELLAT, R., Dissipative instability associated with electrons trapped in tokamak-type configurations, 25:59060 (CEA-CONF-1800)
PELLEGRIN, J.-L., Proportional wire chamber electronics system utilizing CAMAC, 25:59656
PELLEGRINI, G., Substructure of γ-vanadium suboxide resulting from long range ordering of oxygen, 25:58392
PELLIONISZ, P., Correlation technique at pulsed neutron sources, 25:59672 (KFKI-71-45)
PELTIER, Daniel, Preparation and control of the functioning of a mercury cathode cell working at an imposed potential, 25:60295 (UCRL-Trans-10548)
PEMPINELLI, F., Some consequences of the asymptotic scaling assumption, 25:59342
PENFOLD, J. E., Radial velocity of Delta Scuti star 20 CVn, 25:58460
PENIONZHKEVICH, Yu. E., Production and decay of compound nuclei in high-energy heavy ion reactions, 25:59779 (JINR-P7-5912)
PENN, J., K$^+$N charge-exchange reaction at 5.5 GeV/c, 25:59305
PENNINGTON, M. R., Constraints imposed on $\pi^0\pi^0$ s- and d-waves by analyticity, crossing, and positivity, 25:59458
PENNY, A. J., Effective temperatures and gravities for A- and F-type stars, 25:58476
PERAS, A. Ya., Statistical methods of determining the thermal-shock resistance of refractories, 25:58376
PERCEVAL, F., Deformation of the electron distribution function under the influence of a large amplitude wave, 25:59012 (CEA-CONF-1833)
PERCHEREAU, Jeanine, Mechanism of reactions (d,p) and (d,t) induced by low energy (120 to 200 keV) deuterons on ^{9}Be. Determination of characteristics of excited levels of ^{11}B obtained by reactions ^{9}Be + d, 25:59827 (CEA-R-4070)
PERELOMOV, A. M., Scattering, reactions, and disintegrations in nonrelativistic mechanics, 25:59612
PEREY, F. G., Elastic scattering of 40-MeV protons from ^{48}Ti, /sup nat/Cr, and ^{64}Zn: tabulated differential cross sections, 25:59739 (ORNL-TM-3591)
PEREZ, J., Anelastic properties of irradiated aluminum cold-worked at low temperature, 25:58338
  Nature of the impurity phase in a age-hardenable Mg-10.8

wt. percent Y alloy, 25:58293
PEREZ MEDINA OLLIVARY, Victor, Measurement of thicknesses of various materials using Si(Li) and surface barrier detectors, 25:57865 (NP-18941)
PEREZ-MENDEZ, Victor, Self-triggered wire chambers for radiation imaging purposes, 25:57784
PERILLI, M. L., Nuclear energy in Europe, 25:59901
PERKINS, R. B., New (p,n) reaction studies at Ep = 23 MeV, 25:59789
PERKINS, S. T., Evaluated nuclear cross section library, 25:59783 (UCRL-50400(Vol.4))
PEROLA, G. C., Polarization and the magnetic field scale in radio sources, 25:58532
PERRICOS, D. C., System for the production and study of bromine delayed neutron precursors from fission, 25:57504
PERRIN, R., Partial wave amplitudes for π^-p elastic scattering and charge exchange in 2 to 5 GeV/c region, 25:59304
PERRIN, R. C., Theory of void growth in irradiated materials, 25:58312
PERRY, K. E. G., Development of thermoluminescence dosimetry systems, 25:57840
PERSSON, G., Debris over Sweden from the Chinese nuclear weapon test September 1969, 25:57580
PERSSON, Gunnar, Radioactive particles from eighth Chinese nuclear test, 25:57577
PERT, G. J., Neutral-gas acceleration by an electromagnetic plasma gun, 25:59031
PERVES, J. P., Underwater neutron radiography, surveillance of active in-pile tests. First results with cold-neutron radicgraphy, 25:57679 (LB/G-2986)
PESIC, S. S., Lower-hybrid wave--plasma interaction, 25:59084 (CEA-CONF-1827)
  Plasma heating at the lower-hybrid resonance, 25:58960 (CEA-CONF-1831)
PETERSEN, J. Lyng, Information on low-energy $\pi\pi$ interaction from elastic pion--nucleon phase shifts, 25:59463
PETERSEN, V. C., New tin--titanium alloy, 25:58234
PETERSONS, H. F., Uniform electrical conductivity model for Earth and geomagnetic disturbance daily variation, 25:58889
PETERSSON, B., Crossing and isospin symmetric description of anti KN $\pi\pi$ anti Λ system using generalized Veneziano model, 25:59488
PETIT, J. P., Theory of the spiral structure of the galaxy, 25:58634
PETKOV, I. Z., Elastic scattering of high-energy protons on nuclei, 25:59509
PETRASCU, M., Absolute measurement of ^{239}Pu fission cross-section for 2200 m/sec neutrons, 25:59777 (IFA-NR-33)
PETRESCU, N., Viscosity, density, and autodiffusion in molten, equiatomic In--Bi alloy, 25:58238
PETRINA, D. Ya., Kirkwood--Saltzburg equations for coefficient functions of scattering matrix, 25:59622
PETROCHENKO, A. F., Bremsstrahlung from 7- to 10-MeV electrons in thin Si crystals, 25:59149
PETROV, V. S., Deactivation of radioactive sewage by the method of two-step coagulation of ferric hydroxide, 25:57556
PETROV, Yu. N., Anodic dissolution of hard alloys of VK type in alkali--nitrate electrolytes, 25:58177
PETROVA, G. S., Rezarson as a reagent for the spectrophotometric determination of niobium, 25:57333
PETROVIC, V., Contribution to effect of gas pressure in pores on boundary migration and grain growth in sintered UO_2, 25:58408
PETROVSKAYA, I. V., Discontinuous random processes in irregular force field. III, 25:58428
PETTIGREW, George L., State and Federal control of health hazards from radioactive materials, 25:58028 (BRH/DMRE-71-4)
PETTINGER, Donald Stanley, Improvements in and relating to nuclear reactors, 25:60072
PEVTSOV, G. A., Influence of various carriers in the spectrographic analysis of oxides of refractory metals (tungsten and zirconium), 25:57335
PEYRE-LAVIGNE, A., Soft x-ray spectrometry with semiconductors operating in a cascade regime, 25:57771
PEYRE-LAVIGNE, Monique, Soft x-ray spectrometry with semiconductors operating in a cascade regime, 25:57771
PFEIFF, H., Manufacturing and in vivo application of miniaturized semiconductor detectors, 25:57745
PFISTER, H., Large deviations from the scaling law for the proton form factor in the timelike region, 25:59361
PFLEIDERER, J., Near-ultraviolet surface photometry of southern Milky Way, 25:58653
PHILBIN, Jeffrey Stephen, Power shift phenomena in large fast breeder reactors, 25:60044
PHILBIN, P., Comparison of stainless steel and Zircaloy-2 as encapsulation materials for ^{252}Cf, 25:58242
PHILLIPS, A. R., Use of a time-shared, on-line computer to support basic and applied radiation research, 25:59666
PHILLIPS, G. C., Prog. rpt. on nuclear physics, 3/71, 25:59692 (ORO-1316-99)
  Prog. rpt. on nuclear structure at intermediate energies, 3/71, 25:59693 (ORO-1316-100)
PHILLIPS, G. W., Generalized field equations in general relativity, 25:59591
PHILLIPS, J., Time lags in the auroral-zone ionosphere 25:58863
PHILLIPS, R. J. N., Complex Regge poles, 25:59434
  Deductions from new $\pi^-p \to \pi^0n$ data at large momentum transfers, 25:59289
PICARELLI, John Gerard, Multigroup, spatially dependent studies of mild excursions in large fast reactors, 25:60237
PICK, Peter, Parity violation in πN scattering, 25:59487
PIERCE, A. D., Estimation of nuclear explosion energies from microbarograph records, 25:57606
PIERCE, R. D., Chemical Engineering Division fuel cycle technology quarterly report, January--March 1971, 25:57507 (ANL-7799)
  Development of a mixer-settler for liquid metal-salt systems, 25:57508 (ANL-7810)
PIESCH, E., Development of new neutron detectors for accident dosimetry, 25:57857
PIETARINEN, E., Information on low-energy $\pi\pi$ interaction from elastic pion--nucleon phase shifts, 25:59463
PIETRONERO, L., Elementary solutions of Schrodinger equation for some time dependent interactions, 25:59207 (NP-19033)
PIETRZYK, B., Relative K-capture probability in unique first-forbidden decay of ^{145}Sm, 25:59799
PIETRZYKOWSKI, M., Excitation of isomeric activities in Rb, Y, Pd, Cd, W, Os, and Pb using 14.8-MeV neutrons, 25:59797
PIETSCHMANN, H., Non-local effects in the decay of polarized muons, 25:59404
PIGEON, J., Non-exhaustive restatement of the angular momentum reduction in the three-body problem, 25:59206 (LYCEN-7118)
PIKEL'NER, S. B., Formation of prominences, 25:58571
PIKULEV, A. T., Activity of aminotransferase in mitochondria of irradiated animals, 25:57933
PILKINGTON, G. R., Passage of auroral x rays through the atmosphere, 25:58868
PILUSO, C. J., Magnetic analysis of reactions ^{7}Li(^{3}He,d)^{8}Be and ^{7}Li(^{3}He,t)^{7}Be, 25:59731
  Search for high-spin states in ^{27}Al, 25:59761
PINGOT, O., Circular polarization of gamma radiation from ^{58}Co, ^{48}V, ^{52}Mn, and ^{56}Co, 25:59746
PINI PRATO, G., Changes in human saliva during radiation therapy, 25:57945
PINK, E., Low temperature deformation characteristics of neutron irradiated vanadium--titanium alloys, 25:58339
PINNINGTON, E. H., Spectra of neutral and singly ionized holmium, 25:58708
PINTER, G. F., Analysis of the reaction $\pi^+p \to$ rho$^0\Delta^{++}$ at 11.7 GeV/c incident momentum. II, 25:59499
  Analysis of the reaction $\pi^+p \to$ rho$^0\Delta^{++}$ at 11.7 GeV/c incident momentum. I, 25:59315
PISHCHINSKII, A. V., Neurosecretion cells of the dog hypothalamus during acute radiation sickness, 25:58129
PISKUNOV, E. M., Complex formation with DTPA. I, 25:57549
PISUT, J., Extrapolation of scattering amplitudes. IV, 25:59621
PITERIMOV, V. A., Temperature relaxation in metals, 25:58241
PITIMADA, D., Measurement of the effect of twisted tapes on the forced-convection heat transfer and burnout in heat exchangers, 25:57643
PITT, C. H., Effect of neutron irradiation on mechanical properties of rhenium, 25:58342
PLANE, D. E., Baryon decay rates within SU(3), 25:59491
PLATOV, A. I., Spectrometric characteristics of germanium detectors with radiation defects, 25:57822
PLAUT, Walter, Radiation induced DNA synthesis in the polytene chromosomes, 25:57951 (COO-1747-6)
PLAVEC, Miroslav, Two new chapters in story of U Cephei. II, 25:58435
PLECEAS, M., Radioprotective effect of ethylene glycol on bacteria, 25:58157
PLECHATY, Ernest F., Spectra of fast neutrons from water pulsed with 14-MeV neutrons, 25:59674
PLINT, C. A., Formation energies of individual vacancies in alkali halides, 25:60281 (ORO-3344-4)
PLOCHOCKI, A., Decay scheme of ^{232}Pa, 25:59798
PLYUTINSKII, V. I., Some properties of boiling-water reactor self-oscillation conditions, 25:60037
PODDUBSKII, G. A., Change in the level of redox potential in muscles of different animal species as a function of the dose of cystamine introduced, 25:58031
POE, Norman D., Comparative myocardial uptake and clearance characteristics of potassium and cesium, 25:58041 (UCLA-12-837)
  Comparison of radioaerosol versus radioxenon inhalation procedures in obstructive lung disease and pulmonary embolism, 25:58040 (UCLA-12-834)
POETZL, K. G., Investigation into the potential seismological effects of the Cannikin Event, 25:57590 (COO-2138-4)
POGOSYAN, V. A., Steady-state distribution of charged particles in the diffusion approach, 25:59048
POGREBNOI, Yu. P., X-ray sensitivity of semiconductor radiation detectors, 25:57766
POHL, F., Vacuum magnetic fields of linear stellarators with shaped coils, 25:59074 (IPP-1/119)
POIRIER, J. P., Fast neutron irradiation of Al, Mg, and Cu, 25:58310
POKROVSKII, A. V., Choice of source energy and activity for a radiometric method of isotope nondestructive testing, 25:57874

POKROVSKII, B. I., New phases in Sc--V--O system, 25:58401
POLAKOVIC, Anton, High-strain-rate deformation of cadmium single crystals, 25:58252
POLAND, A., Energy balance in cool quiescent prominences, 25:58603
POLDEN, P. G., Measurement of 10-μm flux from Crab Nebula, 25:58541
POLENSKY, F., X-ray dose to the patient in maxillodental tomography, 25:58022
POLKINGHORNE, J. C., Two high energy processes involving detected final state particles, 25:59401
POLONSKII-BULAEV, A. A., Determination of the oxygen content in metallic ruthenium, 25:57329
POLS, C. L., Cross sections and spin-density matrix elements for two-body reactions in 5 GeV/c π^+p two-pronged interactions, 25:59297
POLUBOYARINOV, D. N., Effect of crystal structure disorder of BN on its sintering, 25:58359
POLUEKTOV, N. S., Use of a Tb complex in determination of rare earth elements, 25:57317
POMERANTSEVA, M. D., Mutagenic effects of different types of radiation on germ cells of male mice. VI, 25:57967
POMETUN, E. A., Elimination of the effect of the sample composition on the line intensity of certain rare metal impurities, 25:57330
POMPEI, A., Dispersive approach to ^{4}He(γ,d)d reaction, 25:59698
POMRANING, G. C., Grey radiative transfer, 25:58471
PONOMAREV, E. G., Neutron beams from isotope neutron sources, 25:59690
PONOMARIEV, V. N., Observable effects of torsion in space--time, 25:59605
PONOSOV, A. K., Production of $\pi^+2\pi^-$ on nuclei at small momentum transfers, 25:59316
PONSAR, Christian Marie Maurice Bertrand, Ionization fire detection device, 25:57873
PONTA, A., Transfer annealing in Cr(III) trisacetylacetone, 25:57496
PONTEKORVO, B., New experiments in neutrino physics, 25:59403
POOLE, John W., Induction plasma nozzle tests, 25:57640 (N-71-22591)
POP, Ioan, Plane nonstationary magnetohydrodynamic boundary layer, 25:58847
POPE, Malcolm H., Lubrication aspects of deep drawing of stainless steel, Ti, and Ni-base alloys at elevated temperatures, 25:58195
POPEK, R. J., Chemical Engineering Division. Cross sections and burnup semiannual report, January--June 1971, 25:60035 (ANL-7824)
POPOV, D. K., Coprecipitation of radium with a prototype of the bone mineral calcium hydroxylapatite, 25:57418
  Methods of determination of ^{137}Cs in objects of external environment, 25:57355
POPPER, Daniel M., HD 21242: spectroscopic binary with H and K emission, 25:58461
  Some double-lined eclipsing binaries with metallic-line spectra, 25:58506
POPPOFF, I. G., Ionosphere of Mars below 80 km altitude. II, 25:58676
PORGES, K. G. A., Deadtime correction in counting rapidly decaying sources, 25:57732
PORTAL, G., LiF radiothermoluminescent dosimeters which can be reused without regeneration, 25:57848
PORTER, Richard A., Interaction of silicic acid with Fe(III) and uranyl ions in dilute aqueous solution, 25:57406
PORTER, W. A., Global temperature effects of the use of fusion energy and the fusion torch, 25:58956
PORTNOV, V. F., Residual stresses in cermets, 25:58381
POSEY, J. W., Estimation of nuclear explosion energies from microbarograph records, 25:57606
POSEY, L. D., Magnetic Compton spectrometer for high intensity pulsed gamma ray environments, 25:57813
POSTAN, A., Height and frequency variation of penetrating and non-penetrating modes in the ionosphere, 25:58878
POSTON, J. W., Detector for the measurement of dose distributions at a bone-tissue interface, 25:57851
POSVOL'SKII, M. V., Induced reactions in radiochemistry. V, 25:57411
  Induced reactions in radiochemistry. VI, 25:57413
POTAPOV, Yu. V., Nonrelativistic particles produced in interactions of multicharged cosmic ray nuclei with light nuclei of emulsion, 25:59274
POTAPOVA, A. I., Action of gamma radiation on the adrenal cortex and thyroid gland in the rat, 25:58107
POTTELETTE, R., Possibility of using a quadrupole probe for measuring electric currents in the magnetosphere, 25:58885
POTTER, D. C., Reaction $\pi^-p \to K^+K^-n$ between 988 and 1100 MeV invariant KK mass, 25:59301
POTTER, Wendy Nan Torrance, Vector meson dominance and pion photoproduction, 25:59351
POULTON, D. J., Comment on the defect structure and the transport properties of Nb_2O_5, 25:58391
POVINEC, P., ^{14}C in atmosphere and biosphere, 25:57364
POWELL, Christopher, Nuclear reactor installations, 25:60146
POWELL, J. E., Detection of high explosives by capture gamma-ray techniques, 25:57866 (SC-RR-710450)
  Use of a time-shared, on-line computer to support basic and applied radiation research, 25:59666
POWELL, R. C., Nonlinear responses of poly(vinyl toluene) plastic scintillators at high excitation doses, 25:57765
POWERS, J. T., Limiting distributions for target fragmentation in reactions $\pi^{+-} + p \to \pi^- +$ anything, 25:59319
POWNALL, D. R., Observations on particulates in a sodium loop, 25:58170 (RD/B/N-1998)
POZHAROV, S. L., Charge exchange and transition reactions of a hydrogen atom during collisions of argon ions with water molecules, 25:57460
PRADHAN, T., Equal-time charge-current commutator in quantum electrodynamics, 25:59566
PRAHALLADA RAO, B. S., 60° sector mass spectrometer for gas analysis, 25:57890
PRAKASH, Hari, Nonlinear scattering of partially coherent radiation by free electrons, 25:59225
PRAKASH, S., Electrostatic plasma instabilities in the equatorial electrojet, 25:58900
PRANTSKYAVICHYUS, G. A., Statistical methods of determining the thermal-shock resistance of refractories, 25:58376
PRASAD, B. B., Platinum--graphite electrode system for the biamperometric determination of iodine, 25:57302
PRASAD, C., ESR studies of intrinsic and impurity defects in silica and germania, 25:59174
PRASTEIN, S. Matthew, Suppression of Cherenkov radiation, 25:59219
PRAT, R. F., Stability of self-consistent symmetries in atomic theory, 25:58792
PRATT, R. J., Semiannual variation in height of F2-layer peak, 25:58879
PREDAZZI, E., Multiparticle production model with charge conservation, 25:59512
PREIST, T. W., Density of states in static screened Coulomb potential, 25:58721
PRENTICE, J. D., Production of ρ-meson in $\pi N \to \rho^0 N$ charge exchange channels at 7 GeV/c, 25:59288
PRESNAJDER, P., Extrapolation of scattering amplitudes. IV, 25:59621
PRESTON, H. E., Development of thermoluminescence dosimetry systems, 25:57840
PREVOST, M. A. L., Regge cuts and eikonal approximation in field theory. II, 25:59579
PREVOTEL, Marc, ELAN-2B, pilot plant for ^{137}Cs and ^{90}Sr sources, 25:57482 (ORNL-tr-2535)
PRICE, C. W., Metallographic analysis of carbide structures in cast heat-resistant alloys, 25:58399
PRICE, R. H., Energy levels in ^{191}Ir, 25:59805
PRIDATKO, S. A., Method for determining the coefficients of reactor transfer functions, 25:60229
PRIGENT, R., Detection and alarm system for accidential nuclear excursions, 25:57780
PRO, M. J., Use of neutron activation analysis for the characterization of paper, 25:57374
PRODAN, A., Storage behavior of sintered uranium oxides, 25:58371
PROKOSHKIN, D. A., Study of creep in niobium--molybdenum alloys, 25:58222
PRONINA, M. I., Effect of hygromycin B and streptomycin on Actinomyces hygroscopicus variability induced by x-irradiation, 25:57964
PRONKO, P. P., Stirling cycle cryogenic cooler used with accelerator for radiation effects in thin films, 25:59160
PRONMAN, I. M., Use of fast 14-MeV neutrons for determination of O in pure materials, 25:57376
PROTASOV, V. P., Production of $\pi^+2\pi^-$ on nuclei at small momentum transfers, 25:59316
PRUSAKOV, V. N., Krypton difluoride, 25:57455
PRUSS, Gail, Magnetic fields, bremsstrahlung, and synchrotron emission in flare of Oct 24, 1969, 25:58609
PRYAKHINA, L. I., Heat resistance of nickel-base alloys, 25:58224
PUCKER, N., Evolution operator method and its application to problems of reactor theory, 25:60221
PUCKNELL, V. F. E., Shell-model data from a realistic N--N interaction. III, 25:59723
PUGH, S. F., Conference on voids formed by irradiation of reactor materials, Reading, Eng., 3/71, 25:58304
PULLEN, D. A. W., Radiography applied to gas turbines, 25:57689
PULLIA, A., Background measurement of a Ge(Li) detector, 25:57803
PULLIAM, Robert Lee, Characterization and fractionation of tobacco leaf transfer RNA, 25:60284 (RLO-2225-T-15-7)
PUPYSHEV, A. A., Spectrographic method for determining main components in alloys based on cobalt, 25:57313
PURI, B. K., Polarographic determination of Cd, Co, Mn, Zn, Te(IV), and Cr(VI) in sodium azide solution, 25:57307
PURI, S., Simple low-loss coupling method for RF heating of plasma ions by electrostatic ion-cyclotron waves, 25:58962 (IPP-IV-25)
PURROTT, R. J., Use of radiation-induced chromosome aberrations in human lymphocytes for dosimetry, 25:58014
PURSGLOVE, Diana L., X ray-induced mutations of genetically-determined melanoma system of Xiphophorin fish, 25:57957
PUSHKAREV, V. V., Deactivation of radioactive sewage by the

XUM

method of two-step coagulation of ferric hydroxide, 25:57556
PUSTOVALOV, V. V., Electron deceleration by dislocations in Type-II superconductors, 25:58932
PUTHOFF, Richard L., Preliminary impact speed and angle criteria for design of a nuclear airplane fission product containment vessel, 25:60192 (N-71-25411)
PYATOV, N. I., 0^{+} and 1^{+} unlike particle-hole states in deformed odd--odd nuclei and β-strength functions, 25:59872
PYTTE, E., Phase transitions in β-W structure induced by band Jahn--Teller effect, 25:58272

Q

QUARATI, P., Dispersive approach to ^{4}He(γ,d)d reaction, 25:59698
QUEENER, L., Experimental investigation of fabrication of Th--20 wt. percent U for the UMBR fuel element, 25:58185 (ORNL-TM-3499)
QUEMENEUR, A., Deformation of the electron distribution function under the influence of a large amplitude wave, 25:59012 (CEA-CONF-1833)
QUERE, Y., Dechanneling of particles by lattice defects, 25:59169
QUIGG, C., Regge cut contributions to exotic boson exchange cross sections, 25:59483
  Remarks on pion photoproduction, 25:59362
QUIGG, Chris, Two-Reggeon exchange contributions to hadron scattering amplitudes at high energy, 25:59618
QUINN, H. R., Photoproduction of e^{+}e^{-}, rho--ω mixing and vector dominance, 25:59364
QUINTILIANI, M., Survival of E. coli B/r after x irradiation, 25:58155

R

RABINOVICH, B. S., Separation of Pt from daughter isotope of Au, 25:57554
RABSON, T. A., Average energy expended per ionized electron-hole pair for α particles in Si(Li), 25:57788
RADHAKRISHNAMURTY, C., Titrimetric determination of Fe(II), Mo(V), and Tl(I), 25:57309
RADIVICH, Mirjana M., Identification of radio sources from Ohio survey, 25:58558
RADWAN, M., Excitation of x rays for investigation of diffusion, 25:57673
RAETHJEN, H., Proton measurements in the morning sector of the auroral zone during slowly varying cosmic noise absorption, 25:58891
RAFELSKI, Johann, Superheavy elements and an upper limit to the electric field strength, 25:59554
RAFF, R. A. V., Prog. rpt. on polymer grafting to inorganic substrates, annual, 2/1/70--1/31/71, 25:58416 (RLO-2098-2)
RAFIQUE, M., Lower bounds on total cross-sections for meson--baryon scattering and the modified Pomeranchuk theorem, 25:59474
RAGGETT, Jon D., Approximate procedure for determining building dynamic response characteristics, 25:57592 (JAB-99-70)
RAGHAVAN, R., Ratio of pions to protons and ratio of neutral-to-charged interacting particles at 800 gm/cm^{2}, 25:58834
RAGINSKAYA, L. K., Influence of various carriers in the spectrographic analysis of oxides of refractory metals (tungsten and zirconium), 25:57335
RAHMEL, A., Effect of oxygen pressure on the redox potential of molten molybdenum trioxide, 25:58374
RAI, D. K., Formula for ionization cross section of neutral atoms by electron impact, 25:58738
RAISBECK, G. M., Cross sections for the production of beryllium isotopes from the 880 MeV alpha-particle bombardment of carbon, 25:59733
RAJAGOPAL, A. K., Existence of solutions of two-particle Lippmann--Schwinger equation. II, 25:59626
RAJKOVIC, D., Spectrophotometric determination of traces of silicon as molybdenum blue in uranium dioxide, 25:57340
RAJPUT, B. S., Impossibility of reduction of electromagnetic fields in free space for nonzero-mass system, 25:59347
RAJPUT, M. A., Radiosensitivity studies in sunflower, 25:58148
RAJU, G. V. S., Stability of reactor control systems in coupled core reactors, 25:60051
RAKOBOL'SKAYA, I. V., Complex investigation of extensive air-shower core with energy greater than or equal to 10^{15} eV, 25:59249
RAKOVSKII, E. E., Separation of Pt from daughter isotope of Au, 25:57554
RAMAMOORTHY, S., Stability constants of uranyl ion with mixed carboxylic acids, 25:57402
RAMA RAO, V. V. K., 60° sector mass spectrometer for gas analysis, 25:57890
RAMIREZ, R., Accurate analytical self-consistent-field wave functions for Dy^{2+}, 25:58698
RAM MOHAN, L. R., Sum rules for CP-nonconserving BBπ amplitudes in Glashow's model, 25:59408
RAM MOHAN, Lakshminarayanapuram Ramdas, Weak decays of Ω^{-} particle and current algebra, 25:59398
RAMORINO, C., Photofission of ^{232}Th near threshold, 25:59786
RAMSHESH, V., Isotope exchange and thermal annealing of recoil damage in trisoxinatocobalt(III), 25:57493
RAND, R. E., Real part of the rho--nucleon forward scattering amplitude and the relative rho--ω production phase, 25:59252
RANFT, G., Phenomenological study of inclusive single particle spectra in the triple Regge limit, 25:59505 (JINR-E2-6031)
RANFT, J., Phenomenological study of inclusive single particle spectra in the triple Regge limit, 25:59505 (JINR-E2-6031)
RANGASWAMY, T. N., Ratio of pions to protons and ratio of neutral-to-charged interacting particles at 800 gm/cm^{2}, 25:58834
RANKIN, D. T., Hot pressing techniques for fabricating Cm$_2$O$_3$ for radioisotopic fuel forms, 25:57653 (DP-1270)
RANKIN, J. M., Crab Nebula pulsar radio pulse arrival times, 25:58559
RANNUG, J. Ulf, Photoreactivation of mutational damage produced by interaction between DEB and uv in Neurospora, 25:57954
RAO, A. L. J., Polarographic determination of Cd, Co, Mn, Zn, Te(IV), and Cr(VI) in sodium azide solution, 25:57307
RAO, D. R. K., Spectral study of sunspot number and solar radio flux between 600 and 9400 MHz, 25:58614
RAO, K. N., Kinetics of radiation induced solid state polymerization of trioxane, 25:57453
  Rate constants of reactions of photogenerated solvated electrons with monomers, 25:57475
RAO, K. Narahari, Energy levels and molecular constants of ^{12}C$_2$H$_2$, ^{12}C$_2$D$_2$, and ^{12}C$_2$HD, 25:57433
  Infrared bands of H^{12}C^{15}N, D^{12}C^{15}N, and H^{13}C^{15}N, 25:57421
RAO, M. H., Kinetics of radiation induced solid state polymerization of trioxane, 25:57453
RAO, V. R. S., Behaviour of halide ions towards chloramine-T in qualitative analysis, 25:57303
RAO, V. Surya, Indian experience in construction of nuclear power reactors, 25:59891
RAPEANU, S., Program for the computing of the scattering cross-sections in heavy water, 25:59671 (IFA-DNBR-3)
  Riva--Butler's code, 25:59689
RAPPENEAU, J., Development of properties of nuclear graphite obtained by a mixture of cokes, 25:58366 (CEA-CONF-1820)
RAPPLEYEA, Chloe Annette, Coulomb energies of isospin triplets in 2s--1d shell, 25:59860
RASTOGI, B. P., Conference on nuclear power, Bombay, 1/70, 25:60006 (CONF-700113)
RASTOGI, R. G., Effect of magnetic activity on electron drifts in equatorial electrojet region, 25:58905
RATCLIFFE, B. J., Metal intensifying screens for radiography, 25:57690
RATHER, Yu. E., Kinetics of the reduction of tungsten and molybdenum trioxides by hydrogen, 25:58189
RATIER, J. L., Phenix reactor, 25:60085
RATUSKY, Josef, Process of manufacturing radioactive substances derived from difluorescenylmercury and labelled with radioactive iodine isotopes, 25:58047
RAUCHWERGER, Joel M., Radiation protection studies in adult, weanling, and neonatal mice, 25:58110
RAVKIN, A. S., Sensitivity of fruit and berry plants to gamma radiation, 25:58151
RAVKINA, L. I., Morphological study of organs, blood cells, and bone marrow of white rats and mice with vaccinal disease, 25:58128
RAVNIK, V., Impurities in analytical and suprapure reagents application of activation analysis for determination of Cl, As, Cu, Mn, Na, 25:57379
RAYAVE, E. L., Efficiency of some antioxidants in the thermooxidative degradation of irradiated polyethylene, 25:57462
  Thermostabilization of irradiated filled polyethylene, 25:57446
RAZMADZE, N. A., Properties of dense helium plasma in recombination stages, 25:59016
RAZUMOVA, K. A., Dependence of energy loss from Tokamak plasma on effective electron collision frequency, 25:58974
REDA, Abdu, Sterilizing doses of x-ray for rice and granary weevil, 25:58161
REED, R. E., Production and crystal growth of isotopic rare-earth metals, 25:58184 (CONF-711002-, pp 181-90)
REEDER, D. D., K^{+}N charge-exchange reaction at 5.5 GeV/c, 25:59305
REFORMATSKAYA, I. A., Application of layers of Th, U, Np, and Pu on instrument parts, 25:57440
REGAN, James D., Analysis of repair in human DNA by 5-bromodeoxyuridine photolysis, 25:60268 (CONF-711014-1)
REGNET, K., Nuclear power operated de-salination of sea water under nominal and partial load conditions, 25:60201
REHBACH, J., Gas turbine for a nuclear power plant, 25:60145
REHFELD, G., Complex automation of nuclear power plants, 25:60048
REID, J. S., Time lags in the auroral-zone ionosphere,

XUM

25:58863
REILING, H., Power spectrum analysis of granular intensity fluctuations and velocities, 25:58594
REIMERS, D., Solar transition layer and solar active regions, 25:58580
REINCKE, U., Tumors of albino rats of various ages after single total-body roentgen irradiation, 25:58097 (ORNL-tr-2521)
REISSIG, H., Contamination of soils and plants with ^{90}Sr as consequence of nuclear weapons tests during period 1960--1963, 25:57986
REITAN, A., Elastic and single-charge-exchange scattering of pions by carbon nuclei, 25:59523
REITER, Elmar R., Prog. rpt. on radioactive fallout and disturbances in mid-latitude westerlies, 7/71, 25:57572 (COO-1340-24)
REKALO, M. P., Scattering of γ quanta by nucleons in quark model, 25:59378
REMIZOVICH, V. S., Distribution of energy losses for heavy positive particles in a single crystal, 25:59150
RENARD, C., Detection and alarm system for accidential nuclear excursions, 25:57780
RENAUX, Charley, Handling grip, 25:60259
RENGARAJAN, T. N., Transient gamma-ray sources, 25:58550
RENKEN, James H., Processing codes for group-averaged discrete ordinates cross-section tables, 25:59843 (SC-DR-710320)
REPALOV, N. S., Modulated relativistic electron beams, 25:59211
REPELLIN, J.-P., Measurement of $K_2^0 + 2\gamma$ branching ratio and search for $K_1^0 + 2\gamma$ decays, 25:59264
REPENKO, K. N., Effect of synthesis temperature on the sintering of boron nitride, 25:58358
RESNICK, Michael A., Genetic repair and synthesis of nitrate reductase in U. maydis after uv irradiation, 25:57955
RESTELLI, G., Background measurement of a Ge(Li) detector, 25:57803
REVESZ, L., Characterization of small size lymphoid cells in irradiated and normal mouse bone marrow, 25:58120
REYES LUJAN, Javier, Radiolysis of petroleum products, 25:57478
REYNOLDS, E., Constant geometry approach to in situ seabed gamma monitoring, 25:57586
RHEIN, Walter J., Monochromatic reflection effect of close binary stars, 25:58451
RHINES, F. N., Prog. rpt. on quantitative determination of the structure-property relationships in nuclear fuel element materials, 3/15/71--6/15/71, 25:58389 (SRO-552-8)
RIBAROV, S., Gamma-radiation-induced changes in SiC semiconductor varistors, 25:57903
RICAUD, C., Temperature dependence of the average energy per electron--hole pair in germanium, 25:57739
RICH, Arthur, High-field electron g -2 measurement, 25:59560
RICHARD, C., Probe geometry effects on turbulent plasma diagnostics, 25:58983
RICHARDS, A. G., Optical generation of electron plasma waves, 25:59101
RICHARDS, D. W., Crab Nebula pulsar radio pulse arrival times, 25:58559
  Mapping of solar polarization at 7.8 GHz, 25:58620
RICHARDS, William Robert, Radiation potentiation by iodoacetamide, 25:58034
RICHMOND, D. R., Effects of airblast on sheep in two-man foxholes, 25:60272 (DASA-2711)
RICHTER, D., Construction of response matrices in γ-scintillation spectrometry, 25:57795 (LB/G-3075)
RICKARD, C. L., Gas cooled fast breeder reactor, 25:60009 (CONF-710922-5)
RIEKE, G. H., Map of galactic nucleus at 10 μm, 25:58639
RILEY, Merle E., Turning-point error in matrix elements involving JWKB wave functions, 25:58737
RIMINI, E., Proton dechanneling in Ge probes, 25:59130
RIMPAULT, M., Consistency conditions between SU(3) and exchange degeneracy for meson--baryon scattering, 25:59493
RINAUDO, G., Analysis of A_1 and A_2 regions in reaction $\pi^+p + \pi^+\pi^+\pi^-p$ at 5 GeV/c, 25:59475
RIORDAN, F., Singularities of the S-matrix, 25:59613
RIPKEN, G., Beam expansion and increase of the Amman--Ritson luminosity limit by coupling and undamping of betatron oscillations, 25:59645 (SLAC-Trans-134)
RIPP, A. G., Choice of source energy and activity for a radiometric method of isotope nondestructive testing, 25:57874
RIPSKITE, P. V., Theoretical calculation of energy levels for rare earth element ions, 25:58709
RISBET, A., Fast neutron irradiation of Al, Mg, and Cu, 25:58310
RISK, Clifford G., Efficient Monte Carlo event generation method for multiperipheral models, 25:59213
RISKA, D. O., Nature of the two-pion exchange contribution to the nuclear force, 25:59870
RITSKO, J. J., Experimental study of ω neutral decays, 25:59320
RITTENHOUSE, P. L., Deformation and rupture behavior of light-water reactor fuel cladding, 25:60118 (ORNL-4727)
  Fuel-rod failure and its effects in light-water-reactor accidents, 25:60126
RITZMAN, Robert L., Prog. rpt. on applicability of data to the description of reactor accident, 4--6/71, 25:60111 (BMI-1917)
RIVERS, R. J., Localisability and single-particle exchange amplitudes, 25:59454
RIVIERE, A. C., Penetration of fast hydrogen atoms into a fusion reactor plasma, 25:59030
ROBASCHIK, D., Transformation properties of states at infinite momentum II, 25:59321 (JINR-E2-5993)
ROBBINS, R. R., Reduced helium abundances in nebulae, 25:58446
ROBERT, G., Electric conductivity of solid solutions of $(ThO_2)_{0\ 75}$--$(CeO_2)_{0\ 25}$ at high temperature, 25:58368
ROBERTS, F. P., Summary report on analysis of semi-fluid condition in PG-[illegible] phosphate glass solids container, 25:57702 (BNWL-[illegible]112)
ROBERTS, Geoffrey Alfred, Improvements in and relating to nuclear reactors, 25:60072
  Improvements in and relating to nuclear reactor fuel elements, 25:60084
ROBERTS, K. V., Solution of partial differential equations using symbolic style of Algol, 25:59216
ROBERTS, P. H., Transformation of the stellar wind equations, 25:58463
ROBERTSON, D. E., Natural cesium in sea water, 25:57301 (TID-25776)
ROBERTSON, David S., Sedimentary uranium deposits, 25:57584
ROBIN, M. G., Phenix reactor, 25:60077
ROBINS, Leonard, Lubrication aspects of deep drawing of stainless steel, Ti, and Ni-base alloys at elevated temperatures, 25:58195
ROBINSON, B. J., Search for southern OH--ir objects, 25:58466
ROBINSON, Earl W., State and Federal control of health hazards from radioactive materials, 25:58028 (BRH/DMRE-71-4)
ROBINSON, J. C., Investigation of boiling detection in the HFIR using out-of-core instrumentation, 25:60181
ROBINSON, J. S., Light emission from gamma-irradiated alkane glasses containing olefins, 25:57463
ROBINSON, M. J., Thermal contact resistance by reflection of heat diffusion waves, 25:57644
ROBKIN, Maurice, Development of a method of neutron radiography of mixed oxide fuels using radiographic analogs, 25:57698
ROCKMORE, Ronald, Unitarization, Castillejo--Dalitz--Dyson poles, and scalar companions, 25:59466
RODEAN, Howard C., Nuclear-explosion seismology, 25:57593 (TID-25572)
RODENBERG, R., Veneziano-type representations of the pion form factor and couplings of photons to heavy vector mesons, 25:59352
RODGERS, A. W., Spectrum of AP Lib (PKS 1514-24), 25:58658
RODGERS, Douglas N., Characterization of a diffusion tube hydrogen detector in a dynamic sodium system, 25:57877
RODIER, J., Exposure of human beings to natural and artificial sources of ionizing radiations, 25:57994
RODIONOV, V. I., Density computation for galactic model of L. Perek, 25:58641
RODIONOVA, G. N., Isolation of berkelium on a zirconium phosphate--silicate sorbent, 25:57530
ROEDER, R. C., Possible selection effect in measurement of quasar redshifts, 25:58567
ROESLER, H., Angiography, scintillation scanning, and ultrasound tomography of liver, 25:58044
  Leakage phenomenon in thyroid gland tumors, 25:58056
ROGANOV, V. S., Angular distribution of the low energy neutrons from the nuclear μ-capture in sulfur and calcium, 25:59738 (JINR-P1-6029)
ROGERS, F. J. G., Preparation of stable and active nuclide targets, 25:59635 (CONF-711002-, pp 91-100)
ROGERS, R. C., Programmable data acquisition interface, 25:59665
ROGOZHIN, Yu. A., Group deformations and relativity, 25:59531
ROLFS, C., K/sup π/ = 1^+ rotational band in ^{18}F, 25:59715
ROMAIKINA, E. P., Elimination of the effect of the sample composition on the line intensity of certain rare metal impurities, 25:57330
ROMAN, William S., Parameter identification in a nonlinear reactor system, 25:60042
ROMANESCU, Gh., Radioprotective effect of ethylene glycol on bacteria, 25:58157
ROMANOV, V. P., Differences in radiation-induced lesions of chromosomes of embryonic meristem of Crepis capillaris seeds, 25:57968
ROMANOV, Yu. N., Two-component and four-component theories of neutrino, 25:59407
ROMANOVA, A. V., Structure of gallium--indium alloys in the molten state, 25:58276
ROOK, D. A., Capacitance characteristics of lithium-drifted pin-diodes mounted together with a cooled FET stage, 25:57802
RORDEN, Robert J., Power meter for measurement of radiation, 25:57761
ROSE, David, LMFBR safety, 25:60132
ROSENBERG, T. J., Energetic electron precipitation near the plasmapause, 25:58897
  Relationship of interplanetary parameters and occurrence of magnetospheric substorms, 25:58856

ROSENBLUM, Arnold, Classical charge symmetric theory of the photoproduction of scalar mesons, 25:59338
ROSENTHAL, Carey M., Solution of the delta-function model for helium-like ions, 25:58805
ROSMAN, N. Paul, Schilder's disease. Positive brain scan, 25:58048
ROSS, C. P., Prog. rpt. on ^{60}Co power and heat sources, 4--6/71, 25:57654 (DP-1279)
ROSS, John, Kinetic energies of ionization products from collisions Ar--Ar and He--He, 25:58764
ROSS, L. E., Feasibility study of the identification of fuel-cladding failures using sodium-soluble isotopic tags, 25:60083 (ANL-7785)
ROSTEK, J., Possibilities of spectrophotometric determination of U in washing, processing, and waste waters from nuclear power plants, 25:57343
ROTENBERG, M. A., Electromagnetic wave tails in second approximation to Einstein--Maxwell equations, 25:59350
ROTH, Etienne, Method and apparatus for the purification of heavy water, 25:57545
ROTH, S., Experimental investigations of exotic semiconductors for nuclear particle detection, 25:57807
ROTHE, Heinz J., nanti p annihilation at rest in a dual model for $\pi\pi\pi$Nanti N-five point function, 25:59465
ROTTNER, Gerard, Apparatus for determining the density of pulveralent materials in reservoir by means of a radioactive source and detector, 25:57872
ROUSSEAU, J. C., FLINA code, 25:60112 (CEA-CONF-1797)
ROVERA, S., Clinical and technical observations in therapy with 42 MeV betatron, 25:58076
ROW, Thomas H., Reactor containment-building spray systems for fission-product removal, 25:60086
ROY, P., Single particle electroproduction at large Q^2 and role of wee partons, 25:59387
ROY, Prodyot, Characterization of a diffusion tube hydrogen detector in a dynamic sodium system, 25:57877
ROY, T., Positive width and S-wave scattering length in πlambda scattering in Veneziano model, 25:59473
ROYCHOUDHURY, R. K., Partial wave amplitudes for π^-p elastic scattering and charge exchange in 2 to 5 GeV/c region, 25:59304
ROYET, Jean, Superconducting conductor, 25:58954
ROZENBLYUM, N. D., Neutron detector, 25:57728
ROZENBLYUM, V. P., Highly sensitive methods for determining traces of Mo. IV, 25:57336
ROZENTAL, I. L., Angular distribution of particles produced in multiple processes, 25:59327
ROZHNOV, G. V., Angular and momentum distributions of μ^- mesons in reaction $\nu + Z \to \mu^- + W^+ + Z$, 25:59414
ROZKOVSKII, D. A., Diffuse radiation of Galaxy in far uv, 25:58638
RUBEL, Paul, Reliability-engineering methods in reactor-safety technology, 25:60125
RUBINOVA, E. E., Formation and annealing of radiation defects in Ge, 25:59159
RUBIO, Andre, Comparative study of the relation between the electric conductivity and grain size in sintered uranium dioxide, 25:59184
RUBTSOV, A. N., Activity of Al, V, and Cr in binary Ti alloys, 25:58220
RUBY, Lawrence, Kinetic distortion in a TRIGA reactor with an asymmetric reflector, 25:60162
RUCK, H. M., Nucleon form factor at high energies, 25:59339
RUDERMAN, Malvin A., Extreme regimes of temperature and pressure in astrophysics, 25:58520
RUDIN, H., Investigation of ^{6}Li(d Vector,α)^{4}He reaction, 25:59737
RUFEH, F., Thermionic performance of CVD tungsten emitters, 25:58839 (TEE-4125-5)
RUFFENACH, J. C., Chemical consequences of reaction ^{238}U(n,γ)^{239}U, 25:57488
RUGE, I., Semiconductor GM counter, 25:57747
RUNDEL, R. D., Cross sections for electron-impact ionization of multi-electron ions. II, 25:58769
RUNDQUIST, D. E., Application of photoinduced reactions to nuclear materials safeguards problems. Project summary report, July 1, 1970--June 30, 1971, 25:57704 (GULF-RT-A-10826)
RURARZ, E., Excitation of isomeric activities in Rb, Y, Pd, Cd, W, Os, and Pb using 14.8-MeV neutrons, 25:59797
RUSAKOVA, V. P., Successive determination of uranium and thorium in oxides of the rare earth elements, 25:57341
RUSIN, L. Yu., Angular distribution of products of reactions proceeding through formation of a long-lived complex, 25:58773
RUSTAMOV, S., Separation of Ru, Rh, and Pd by coprecipitation with ferric hydroxide, 25:57552
RUTKEVICH, N. Ya., Discriminatory development of alpha particle and proton recoil tracks in type K emulsion layers, 25:57731
RUTKOWSKI, Wladyslaw, Possible uses of plasma in powder metallurgy, with particular reference to spheroidization, 25:58187 (SCL-T-710281)
RUTLEDGE, Felix, Vesicovaginal fistula, radiation, and gynecologic cancer, 25:58135
RUTMAN, D. S., Making heating elements on the basis of zirconium dioxide for high-temperature furnaces, 25:58357
RUUSKANEN, P. V., Non-exponential decays in Lee model with several unstable V-particles, 25:59438
RYABOVA, T. Ya., Effect of secondary emission on potential of metallic body in radiation fields of the Earth, 25:59115
RYABTSEV, L. A., Heat resistance of nickel-base alloys, 25:58224
RYAZANOV, M. I., Distribution of energy losses for heavy positive particles in a single crystal, 25:59150
RYBICKI, G. B., A mofified Feautrier method, 25:58470
RYKOV, A. G., Complex formation with DTPA. I, 25:57549

S

SACCOMANNO, Geno, Biology of carcinoma in situ of the lung, 25:60269 (COO-1826-17)
SACKETT, Joseph F., Scintillation scanning of liver cell adenoma, 25:58046
SACKETT, W. M., Uranium geochemistry of the Gulf of Mexico, 25:57587
SADASIVAN, S., Gamma spectrometric measurement of soil radioactivity, 25:57567
SADEKOV, Kh. M., Determination of impurities in pyrographite by method of delayed coincidences of β and γ radiation, 25:57389
SADOVSKII, E. P., Effect of crystal structure disorder of BN on its sintering, 25:58359
SAFRONOV, A. N., Photon radiation during weak interaction of polarized leptons, 25:59402
SAFRONOVA, U. I., Magnetic-dipole transition operator with an accuracy to α^2 for atoms with one or two electrons, 25:58803
SAGANEK, A., Reactions ^{9}Be(d,α_0)^{7}Li (ground state) and ^{9}Be(d,α_1)^{7}Li* (470 keV), 25:59721
SAHAI, Vineet, Correlation of screening constants for K level for atoms of different Z, 25:58817
SAHOTA, H. S., K-conversion coefficient of 80 keV transition in ^{144}Pr, 25:59790
SAIKI, Masamichi, Strontium concentrations in water of north Pacific and seas of Japan, 25:57310
SAITO, Takesi, Lepton--baryon resonances and duality in weak processes, 25:59395
SAITO, Tatsuya, Study of photo-nuclear reaction by means of residual nucleus method, 25:59815
SAITO, Yasutoshi, Thermal decomposition of hydrous oxide and oxycarbonate of thorium, 25:57407
SAITTA, Frank P., Effects of low frequency vibrational stress on the genome of Drosophila melanogaster, 25:57953
SAKAI, E., Recent topics on semiconductor radiation detectors, 25:57793
SAKAI, Eiji, Slow pulses from germanium detectors, 25:57818
  Some observations on germanium γ-ray spectrometers made from high purity p-type material, 25:57820
SAKAI, Takeshi, Thermal and nuclear power generation envisaged for active 1970's, 25:59906
SAKAI, Yoshiko, Significance of Pariser method for evaluation of one-center electron repulsion integral, 25:58808
SAKAI, Yosiki, Lepton--baryon resonances and duality in weak processes, 25:59395
SAKAKURA, Arthur Y., Composite particles in many-body systems, 25:59232
SAKAMOTO, K., Production of ^{26}Al and ^{22}Na, 25:59753
SAKISAKA, Masakatsu, Isotope dependence in K, L, and M shell ionization cross sections by ^{3}He$^+$ and ^{4}He$^+$ bombardments, 25:58776
SAKISAKA, Masao, Nuclear power as source of energy in Japan, 25:59903
SAKUMA, Maki, Radioimmunoassay for canine growth hormone, 25:57909
SAKURAI, Akira, Burn-out in transient boiling heat transfer, 25:57647
SAKURAI, Kenji, Mutual effects of sublethal hemorrhagic shock and subsequent whole-body irradiation, 25:58109
SALAMOV, R. F., Comparison of calculated and experimental dose fields of a proton beam, 25:58023
SALEEM, M., Lower bounds on total cross-sections for meson--baryon scattering and the modified Pomeranchuk theorem, 25:59474
SALIN, Ph., Consistency conditions between SU(3) and exchange degeneracy for meson--baryon scattering, 25:59493
SALPETER, E. E., Fragmentation of supermassive disks, 25:58668
  Solid-state astrophysics, 25:58448
SALTER, C. J., Are the galactic loops supernova remnants, 25:58628
SALTZER, C. E., Investigation into the potential seismological effects of the Cannikin Event, 25:57590 (COO-2138-4)
SALUSTI, E., Elementary solutions of Schrodinger equation for some time dependent interactions, 25:59207 (NP-19033)
SALVATORI, Romano, Systematic approach to safety design and evaluation, 25:60135
SAMEDOV, V. V., Dosimetric characteristics of silicon detectors for gamma radiation, 25:57850
  Spectrometric characteristics of germanium detectors with radiation defects, 25:57822
SAMPAIO, A. Oliveira, Techniques for preparation of UO$_2$--

niobium (cr molybdenum) cermets, 25:58348 (LFEN-NI.-53-a)
SAMSONOV, G. V., Effect of heating by glow discharge on the physico-chemical surface condition of solid alloys, 25:58233
  Modification of cast zirconium by additions of transition metals, 25:58258
  Surface nitriding of zirconium, 25:58173
SANATINA, V. N., Deactivation of radioactive sewage by the method of two-step coagulation of ferric hydroxide, 25:57556
SANDERS, W. L., Improved method for computing membership probabilities in open clusters, 25:58437
SANDERSON, M. D., High-temperature oxidation of some oxidation-resistant copper-based alloys, 25:58171
SANO, Kenji, Real time reactor simulation on a hybrid computer, 25:60218
SANSONE, M. M., Nuclear energy in Europe, 25:59901
SANSONI, B., Bibliographies in nuclear science and technology. Section 14, 25:57368 (AED-C-14-5)
SANTAPPA, M., Stability constants of uranyl ion with mixed carboxylic acids, 25:57402
SANTORI, G., Radiotoxicological analyses used at CNEN, 25:57347 (RT/PROT-(71)9)
SANTORO, R. T., Calculation of the nucleon- and pion-induced star and flux distributions from 400-GeV proton interactions in iron, 25:59507 (CRNL-4673)
SAPERSTEIN, E. E., Method of calculating low-lying spectra in spherical nuclei, 25:59884
SAPORA, O., Survival of E. coli B/r after x irradiation, 25:58155
SARGENT, W. L. W., How to find young galaxies, 25:58625
SARKANY, A., Isotope effect study in catalytic exchange of ethane, 25:57428
SARKAR, Ajit K., Gravimetric determination of molybdenum(VI) with salicylhydroxamic acid, 25:57308
SARKISYAN, R. S., Investigation of ternary solid solutions $Ni_3(Fe,V)$, 25:59188
SARMA, N. V. G., Lunar occultation observations of 25 radio sources, 25:58538
SARO, S., ^{14}C in atmosphere and biosphere, 25:57364
SARYGIN, A. P., Hydrodynamic problems of vessel-type boiling-water reactors, 25:60065
SASA, T., Crystal structure of graphite bromine lamellar compounds, 25:58404
SASAKI, Takashi, Examples of stress analysis of structures by finite element method, 25:60142
SASAYAMA, Tatsuo, Three phase region in system UO_2--PuO_2--Pu_2O_3, 25:58409
SATAKE, M., Leak rate test on reactor containment vessel for Mihama Power Station, 25:60000
SATO, Katsuhiko, Neutron star models, 25:58493
SATO, Kazuo, High-temperature electron plasma by slow mirror theta pinch, 25:59021
SATO, Kimihiko, Study of immediate retransplantation of x-irradiated mandible after mandibular resection. I, 25:58132
SATO, Shigeo, Theory of gravity in framework of Lorentz covariant and second quantized formalism, 25:59547
SATO, Shoichi, Conceptual design of the reactant flow loop for fissicchemical studies, 25:57613 (JAERI-Memo-4446)
SATO, Takeo, Study of photo-nuclear reaction by means of residual nucleus method, 25:59815
SATO, Tomotaro, Present status of national research project on food irradiation, 25:58159
SAVATTERI, C., Closed gas turbine cycle for a 1000-MWe gas-cooled Fast Breeder Reactor, 25:60137 (KFK-1409)
SAVEL'EVA, T. I., Ion exchange fibers and fabrics. II, 25:57555
SAVIT, R., Bound on absorptive part of elastic scattering amplitudes, 25:59630
SAVITSKII, E. M., Alloys of yttrium with dysprosium and holmium, 25:58274
  Effects of thermal cycling of monocrystals of tungsten--molybdenum alloys, 25:58247
  System molybdenum--nickel--carbon, 25:58290
SAVU, V., Absolute measurement of ^{239}Pu fission cross-section for 2200 m/sec neutrons, 25:59777 (IFA-NR-33)
SAXE, R. F., Detection of boiling in nuclear reactors, 25:60089
SCAGGS, R. A., Safety summary report: SPERT-III fuel in Paducah demonstration Cask (Packaging of radioactive and fissile materials). Final report, 25:57703 (DPSPU-71-124-4A)
SCHABERT, Hans-Peter, Steam generator, particularly for pressurized water nuclear reactors, 25:60144
SCHAEFER, Hermann J., Radiation exposure in air travel, 25:58138
SCHAEFER, L., Thorex two-stage process for reprocessing thorium reactor fuel with high burnup, 25:57541
SCHAERER, R., Cellular ultrastructure and mitotic index of lymphocytes of leukemia during treatment by irradiation, 25:58131 (CEA-CONF-1768)
SCHAFER, L., New values for partial-wave electron scattering factor for elements 1 less than or equal to Z less than or equal to 57 and 72 less than or equal to Z less than or equal to 90, 25:58748
SCHALE, C., Thermal neutron capture investigation of the ^{172}Yb and ^{174}Yb level structures, 25:59825
SCHARENGUIVEL, J. H., Low mass I = 0 S-wave $\pi\pi$ phase shift, 25:59306
SCHATTEN, Kenneth H., Current sheet magnetic model for the solar corona, 25:58616
  Large-scale properties of the interplanetary magnetic field, 25:58582
SCHECHTER, J., $\Delta I \to 1$ mass differences and eta → 3π decay, 25:59380
SCHECTER, D. J., Prog. rpt. on polymer grafting to inorganic substrates, annual, 2/1/70--1/31/71, 25:58416 (RLO-2098-2)
SCHELL, K. J., Origin of lithium precipitation centers in germanium, 25:57735
SCHENCK, H., Change-over to new forms of energy in the iron and steel industry, 25:60200
SCHENTER, R. E., Neutron spectra from (α,n) reactions in plutonium compounds calculated from Hauser--Feshbach reaction theory, 25:59708 (BNWL-B-109)
SCHEUER, J. C., Experimental study of two-body and quasi-two-body reactions in K^-n interactions at 3 GeV/c, 25:59291
SCHIELDGE, J. P., Empirical determination of aerodynamic factors for the magnetosphere, 25:58908
SCHILD, Rudolph E., Energy distributions and spectra of Orion B stars, 25:58503
SCHLAGHECK, W., Lifetimes and relative initial-state populations of some hydrogen atomic states using beam--foil spectroscopy, 25:58722
SCHLAPPER, Gerald A., On-line, digital data handling and optimal control investigations at the Missouri University Research Reactor, 25:60185
SCHLIER, Ch., Electronic excitation in fast collisions of Na with SO_2 and NO_2, 25:58749
SCHLITT, D. W., URCA process at high temperatures and densities, 25:58492
SCHMELING, Per Erik, Method of producing gaseous nuclides, 25:57485
SCHMID, C., Experimental test of semi-local duality in $K^-p \to$ anti K^0n backward scattering, 25:59482
SCHMID, E., Relevance of chromosome aberration yields for biological dosimetry after low-level occupational irradiation, 25:58015
SCHMID, L. A., Variational formulation of relativistic fluid thermodynamics, 25:58674
SCHMIDT, Gail D., State and Federal control of health hazards from radioactive materials, 25:58028 (BRH/DMRE-71-4)
SCHMIEDER, H., Aqueous reprocessing of fast breeder fuel elements, 25:57518 (EURFNR-888)
SCHNAUDER, H., Change of interpretation of the intermediate heat exchanger for the sodium cooled reactor using ferritic steel design, 25:57614 (KFK-1387)
SCHNEIDER, R. T., Plasma diagnostics of a uranium plasma, 25:59000
SCHNYDERS, H. C., Prog. rpt. on physical chemistry of liquid metals and molten salts, semiannual, 1--6/71, 25:58387 (ANL-7823)
SCHOLER, M., Ambipolar diffusion along magnetic field lines in presence of an electric current, 25:58862
  Solar particle event of March 1970, 25:58892
SCHOTANUS, D. J., Cross sections and spin-density matrix elements for two-body reactions in 5 GeV/c π^+p two-pronged interactions, 25:59297
SCHROCK, B. L., Isospin invariance in reaction $np \to \pi^0d$, 25:59268
SCHROCK, S. L., Metallography of the 300 series stainless steels exposed to high temperature sodium, 25:58174
SCHROECK, F. E. Jr., Generalization of Cook formalism for Fock space, 25:59580
SCHROEDER, A. N. F., Capacitance characteristics of lithium-drifted pin-diodes mounted together with a cooled FET stage, 25:57802
SCHUELE, W., Static crowdions in electron-irradiated Au-15 at. percent Ag alloys, 25:59153
SCHUERMANN, D., Lifetimes and relative initial-state populations of some hydrogen atomic states using beam--foil spectroscopy, 25:58722
SCHULTE, R., $\pi\pi$ scattering effects in π^+p interactions at 8 GeV/c, 25:59296
SCHULTZ, A., Electronic excitation in fast collisions of Na with SO_2 and NO_2, 25:58749
SCHULZ, F., Depth distribution of characteristic x-ray production in Cu by 12- to 30-keV electrons, 25:58685
SCHULZ, Wallace W., Macroreticular ion exchange resin cleanup of Purex process TBP solvent, 25:57509 (ARH-SA-58)
SCHWARTZ, M., Nature of the impurity phase in a age-hardenable Mg-10.8 wt. percent Y alloy, 25:58293
SCHWARTZ, M. J., Nonlinear harmonic generation in a thermal magnetized plasma, 25:59013 (CEA-CONF-1835)
SCHWARZ, F. F., Radiative corrections to inelastic e^-p scattering, 25:59366
SCHWARZ, W. H. Eugen, Variational potentials and Lagrangian multipliers in pseudopotential theory, 25:58814
SCHWEDA, M., Interpretation of anomalies in Ward identities, 25:59572
SCHWEGLER, N., Angiography, scintillation scanning, and ultrasound tomography of liver, 25:58044
SCHWEIGHOFER, Augustin, High-strain-rate deformation of cadmium single crystals, 25:58252
SCHWEIZER, Philipp F., Design of specifically optimal filters for nuclear reactor systems, 25:60248
SCHWENTEK, H., Regular and irregular behaviour of the winter anomaly in ionospheric absorption, 25:58880

XUM

SCHWETJE, W., Synthesis solutions of multigroup Boltzmann equation for slabs, 25:60214
SCIAMA, D. W., Gravitational wave astronomy: an interim survey, 25:59607
SCIUTO, S., Zeros of dual resonant amplitudes, 25:59625
SCOTT, R. L., Failures of threaded fittings and fasteners at nuclear facilities, 25:57618 (ORNL-TM-3570)
SCREM, G., Effect of zirconium additions on the creep strength of aluminum--copper alloys, 25:58239
SCULLY, J. C., High-temperature oxidation of some oxidation-resistant copper-based alloys, 25:58171
SEAMAN, G. G., Analysis of contaminations in biological samples by heavy ion scattering, 25:57359
SEARLE, L., How to find young galaxies, 25:58625
SEBASTIAN, K. J., Once-subtracted dispersion relations, current algebra, and nonleptonic weak decays of hyperons, 25:59409
SEBILLOTTE, Ph., Ion implanted nuclear particle detectors, 25:57809
SEEGER, A., Static crowdions in electron-irradiated Au-15 at. percent Ag alloys, 25:59153
SEGRE, Gino, Scaling law for deep-inelastic hadronic scattering, 25:59428
SEIDOV, Z. F., Stability of a star with a phase change in general relativity theory, 25:58425
SEIICHI, Takayanagi, Radiation detector for insertion into a blood vessel, 25:57760
SEILER, F., Investigation of ^{6}Li(d Vector,α)^{4}He reaction, 25:59737
SEKIYA, Tamotsu, Improvement to the calculation of collision probabilities in annular system and its application to cluster geometry, 25:60235
SELIGA, M., ^{14}C in atmosphere and biosphere, 25:57364
SELIGMAN, T. H., Variational calculation of ^{16}O in the α-particle model, 25:59726
SELINOV, I. P., Isotopes. III, 25:59697
SELISSKII, Ya. P., Investigation of ternary solid solutions $Ni_3(Fe,V)$, 25:59188
SELIVANOV, V. A., Recrystallization and carbide phase formation processes in molybdenum base alloys, 25:58282
SELLE, J. E., Metallographic analysis of cermet fuel forms, 25:58398
  Quantitative analysis of a cermet sphere, 25:58388 (MLM-OP-71006)
SELLERS, A. J., Thermal design of SNAP 8 tantalum stainless steel boiler, 25:60194 (N-71-27855)
SELMES, Rosemary A., Optical monitoring of radio sources. III, 25:58568
SELVA, A. Della, Finite energy sum rules with $\pi\pi$ Veneziano amplitudes, 25:59450
SEMAGIN, V. N., Irradiation of spinal cord, 25:58101
SEMANDERES, Stavros N., ELRAFT a computer program for the efficient logic reduction analysis of fault trees, 25:60134
SEMENENKO, E. E., Anomalous behavior of the superconducting transition temperature of lead with a distorted crystal lattice, 25:58933
SEMENOVA, E. I., Ion exchange fibers and fabrics. II, 25:57555
SEN, Abhijit, Damping of plasma oscillations in atoms, 25:58820
SENFTLE, F., Comparison of stainless steel and Zircaloy-2 as encapsulation materials for ^{252}Cf, 25:58242
SEN GUPTA, N. D., Synchrotron motion with radiation reaction, 25:59359
SENSINTAFFAR, E. L., Improved photographic leak test system for sealed sources of ^{226}Ra, 25:57707
SERDUKE, Franklin James David, Separable potentials in two-, three-, and infinite-nucleon systems, 25:59517
SERGEEV, F. M., Production of $\pi^{+}2\pi^{-}$ on nuclei at small momentum transfers, 25:59316
SERTORIO, L., Remarks on inclusive experiments and high energy models, 25:59322 (NP-19024)
  Two-particle correlations in high energy production experiments, 25:59436
SERVADIO, Sergio, New derivation of the second virial coefficient, 25:59220
SERVANT, C., Aging of ternary Fe--Ni--Mo and quaternary Fe--Ni--Co--Mo alloys, 25:58232
SERYKH, N. V., Gamma-activation method for determining carbon and oxygen in beryllium, 25:57385
SESSLER, A. M., Stochasticity in many-dimensional nonlinear oscillating systems, 25:59652
SESTERO, A., Transverse waves and instabilities in a uniform plasma for propagation along the magnetic field, 25:59102
SETHNA, H. N., National nuclear centres in developing countries, 25:60018
SEVACHERIAN, V., Histopathological studies on irradiated and chemosterilized beet leafhoppers, Circulifer tenellus, 25:58093
SEWARD, F. D., X rays from Puppis A and the vicinity of Vela X, 25:58561
SEYKORA, E. J., K- and L-shell electron shake-off in the beta decay of ^{204}Tl, 25:59792
SEYSS, Ruediger, New evaluation and graphic representation of scintigraphy, 25:58062
SHABALIN, E. P., Angular and momentum distributions of μ^{+} mesons in reactions of direct production of leptonic pairs by neutrino beam in electromagnetic field of nuclei and nucleons, 25:59415
  Angular and momentum distributions of μ^{-} mesons in reaction $\nu + Z + \mu^{-} + W^{+} + Z$, 25:59414
  Angular and momentum distributions of μ^{+} mesons from W^{+}-boson decay in reaction ν/sub μ/ + Z + μ^{-} + Z + W^{+}, 25:59413
SHABANSKII, V. P., Some processes in the magnetosphere, 25:58910
SHABEL'SKII, Yu. M., Possible scaling in hadron production in ee and $e^{+}e^{-}$ collisions, 25:59376
SHADZHYUVENE, S. D., Theoretical calculation of energy levels for rare earth element ions, 25:58709
SHAFIEV, A. I., Separation of actinides and lanthanides on Zr phosphate. I, 25:57550
  Separation of actinides and lanthanides on Zr phosphate. II, 25:57551
SHAFIGULLINA, G. A., Magnetic properties of Sm--Gd alloys, 25:59176
SHAFRAN, I. G., Highly sensitive methods for determining traces of Mo. IV, 25:57336
SHAH, G. A., Model of interstellar grains with surface roughness, 25:58637
SHAH, H. P., Radiation induced ionic polymerization, 25:57450 (ORO-3667-1)
SHAIEVITCH, A. B., Standard reference materials: standard samples issued in the USSR, 25:57297 (NBS-SPEC. PUBL.-260-30)
SHAKAL, A. F., Investigation into the potential seismological effects of the Cannikin Event, 25:57590 (COO-2138-4)
SHAKIN, C. M., Theorem for energy-weighted averages of spectroscopic factors, 25:59855
SHALEK, P. D., Examination of the microstructures of mixed uranium--plutonium dioxide fuel pellets for fast flux irradiation studies, 25:58397
SHAMAEV, V. I., Determination of cobalt in nickel preparations by a radiochemical method, 25:57356
SHAMRAI, A. E., ^{32}P incorporation into protein of liver, spleen, and bone marrow in acute radiation sickness, 25:58123
SHAMSUTDINOV, A. O., Production and decay of compound nuclei in high-energy heavy ion reactions, 25:59779 (JINR-P7-5912)
SHANE, W. W., Neutral H in an interior region of Galaxy. I, 25:58652
SHANKAR, J., Rate constants of reactions of photogenerated solvated electrons with monomers, 25:57475
SHANNON, D., Effects of the neutron pickup process on ^{3}He(p,pd)p quasi-free scattering, 25:59702
SHAPIRO, Edward G., MOSFET current-to-frequency converter with a linear sub picoampere-to-microampere range, 25:57894
SHAPIRO, I. S., New type of baryon resonances, 25:59500
SHARIMANOVA, L. G., Experimental studies of power increase in In--Ga radiation loops, 25:60170
SHARIPOV, E. B., Radioactivation determination of Se, Te, and Au in natural waters, 25:57370
SHARP, David A., Semiempirical formulas for gamma-ray dose rates through two-layer slab shields, 25:59108
SHARP, David Alexander, Neutron and gamma dose rates in two-layered slab shields, 25:59117
SHARPE, R. M., Electron microscope observations of voids in cladding materials irradiated in DFR, 25:58307
SHASTRY, C. S., Existence of solutions of two-particle Lippmann--Schwinger equation. II, 25:59626
SHATURSKAYA, V. P., Microhardness and internal stresses of electrolytic nickel--tungsten alloys, 25:58236
SHCHEGLOV, S. M., Effect of tissue preparations on irradiated animals, 25:58033
SHCHERBAK, V. I., Direct observation of fluctuations of deuterium distribution in $(Nb_{0\ 33}Ti_{0\ 66})D_{0\ 33}$, 25:58278
SHCHUKA, A. A., Electrical resistance and structure of films of W, Mo, and Cr produced by laser evaporation, 25:59186
SHEBZUKHOVA, I. G., Surface energy and work function of the smooth faces of a metallic single crystal, 25:59194
SHEELEY, N. R. Jr., Two-dimensional observations of the velocity field in and around sunspots, 25:58598
SHEIKO, T. I., Fine structure parameters of Al--W, Al--Mo, and Al--Mn alloys obtained at high cooling rates, 25:58284
SHEKHTER, V. M., Deep inelastic hadron production in coliding lepton beams, 25:59371
SHEN, Y. S., Influence of additives on the formation of periodic precipitation (Liesegang bands) in the Ag--Cd system, 25:58262
SHEPARD, R. L., Nuclear reactor applications of new ultrasonic transducers, 25:57898
SHEPHARD, W. D., Limiting distributions for target fragmentation in reactions $\pi^{+-} + p + \pi^{-} +$ anything, 25:59319
SHEPTULENKO, E. V., Discriminatory development of alpha particle and proton recoil tracks in type K emulsion layers, 25:57731
SHER, A. H., Carrier trapping in Ge(Li) detectors, 25:57815
SHERMAN, F. L., Development of manufacturing procedures for HFIR fuel plates to ORNL specification, 25:58349 (ORNL-4713)
SHERSHUKOVA, E. M., Morphological study of organs, blood cells, and bone marrow of white rats and mice with

vaccinal disease, 25:58128
SHERSTYUK, A. I., Structure of irradiated tellurite glasses, 25:57447
SHETULOV, D. I., Study of hardening during fatigue of various pure metals, 25:58223
SHEVCHENKO, V. G., Determination of photonuclear reaction cross sections, 25:59772
SHEVEL'KO, V. P., Orbital quantum number distribution of highly excited atoms produced in collisions between heavy particles, 25:58734
SHEWCHUN, J., Stirling cycle cryogenic cooler used with accelerator for radiation effects in thin films, 25:59160
SHIBAEV, V. A., Stabilization of the heat-output field in fast reactors by control elements, 25:60045
SHIBAROV, V. V., Study of hardening during fatigue of various pure metals, 25:58223
SHIBASAKI, Ichiro, Compton scattering at high energies, 25:59340
SHIBATA, Tokushi, Lifetime measurements of excited states in ^{19}Ne and ^{23}Mg, 25:59719
SHIGA, Toshio, Energy levels of ^{142}Nd, 25:59821
SHIINA, Syoiti, High-temperature electron plasma by slow mirror theta pinch, 25:59021
SHIKANOV, A. S., Investigation of the laser initiated discharge spark channel, 25:59076 (UCRL-Trans-10556)
SHILLINGER, Yu. I., Effect of γ-irradiated fresh fish on rats, 25:58162
SHILOV, V. P., Heptavalent state of transuranium elements. XII, 25:57412
SHIMA, Kunihiro, Isotope dependence in K, L, and M shell ionization cross sections by ^{3}He^{+} and ^{4}He^{+} bombardments, 25:58776
SHIMA, Makoto, Measurement of U, Th in Mn nodules using fission tracks and alpha particle tracks, 25:57570
SHIMADA, K., Electric space potential in a cesium thermionic diode, 25:58838 (N-71-26273)
SHIMANSKAYA, N. S., Activation detector, 25:57729
  Nonrelativistic particles produced in interactions of multicharged cosmic ray nuclei with light nuclei of emulsion, 25:59274
SHIMODA, A., Experimental fast reactor Joyo, 25:60190
SHIMOKAWA, Junichi, Three phase region in system UO_2--PuO_2--Pu_2O_3, 25:58409
SHINAGAWA, Mutsuaki, Rapid separation of fission-product rare earths and yttrium by electromigration, 25:57558
SHIOKAWA, Jiro, Separation factors in a europium chloride--samarium chloride--neodymium chloride--di(2-ethylhexyl)phosphoric acid system, 25:57543
SHIOKAWA, T., Differences between reactions of gaseous CH_3Br with ^{80}Br and ^{82}Br, 25:57492
  Some experimental data conflicting with the explosion model in gaseous bromides, 25:57501
SHIPMAN, H. L., Effective temperature, radius, and gravitational shift of Sirius B, 25:58511
SHIPTON, R. G., Energy response of some commercial beta/gamma and neutron survey instruments, 25:57781
SHIRAFUJI, J., Annealing behavior of bulk n-GaAs irradiated by electrons, 25:59156
SHIRAGAI, Akihiro, Whole-body absorbed dose from x and gamma rays, 25:58004
SHIRAI, Shoji, Estimation of reactor parameters by optimal filtering method, 25:60234
SHIROISHI, Masahide, Carotenoids accumulation and changes of carotenoid pattern of Japanese persimmon by cathode ray irradiation, 25:57926
SHISHOKIN, V. P., Hardness of alloys in the magnesium--cadmium and tellurium--bismuth systems, 25:58253
SHIVAPRASAD, A. P., Pulse characteristics of radio-noise bursts at 3 MHz, 25:58876
SHIZURI, K., Production of ^{26}Al and ^{22}Na, 25:59753
SHLAER, W., Cross sections for (π^{+},p) reactions on ^{9}Be, ^{12}C, and ^{16}O, 25:59710 (LA-DC-12781)
  New measurements of (π^{+},2p) reactions on light nuclei, 25:59709 (LA-DC-12389)
SHOLIN, G. V., Properties of dense helium plasma in recombination stages, 25:59016
SHOSTAK, G. S., Hydrogen line and continuum study of Maffei 2 by radio interferometry, 25:58632
SHOUP, R., Distribution of T/sub </ states in ^{89}Y, 25:59750
SHOWS, Thad N., Log of Hydrologic Test Well 1, Tatum dome area, Lamar County, Mississippi. Dribble-6, 25:57562 (USGS-474-110)
  Log of Hydrologic Test Well 2, Tatum dome area, Lamar County, Mississippi. Dribble-7, 25:57563 (USGS-474-111)
SHREDNIK, V. N., Initial phases in condensation of Zr on W, 25:58229
SHTAN, A. S., Neutron beams from isotope neutron sources, 25:59690
SHTEINBERG, G. A., Highly sensitive methods for determining traces of Mo. IV, 25:57336
SHTUCHKIN, N. N., Transformer for accelerator tube, 25:59648
SHUISKAYA, L. G., Interaction of neptunium with hydrogen peroxide in concentrated solutions of nitric acid, 25:57414
SHUMEIKO, N. M., $\pi^{+} \rightarrow e^{+}(\mu^{+})\nu e^{+}e^{-}$ decays, 25:59412
SHVARTSMAN, V. F., Neutron stars in binary systems should not be pulsars, 25:58424
SHVEDOV, V. P., Electromigration of ions of ^{22}Na, ^{42}K, ^{86}Rb, and ^{134}Cs in molten chlorides, 25:57439
SHVYDKO, N. S., Comparative behavior of ^{89}Sr and ^{140}Ba in skin, 25:57917
  Methods of determination of ^{137}Cs in objects of external environment, 25:57355
SIDORENKO, N. N., Evaporation of tungsten in strong electric fields as stimulated by nitrogen adsorption, 25:58227
SIDORIN, V. P., Activation of concrete shield of OIYaI synchrocyclotron, 25:59657
SIDOROV, V. I., Superconductivity of gallium arsenide at high pressures, 25:58944
SIEBINGER, K., Recovery of resistivity of α irradiated Al foils, 25:59158
SIEGEL, B. V., Detection of antinuclear antibodies in NAB and other mouse strains, 25:60285 (RLO-2226-T-3-8)
SIEGEL, Graham Roger, Optical model analysis of ^{3}He elastic scattering from neighboring even and odd mass nuclei, 25:59769
SIEGELSTEIN, I., ^{153}Eu indirect spin--spin interaction, 25:59200
SIEMINSKI, M., Compound nucleus formation in reaction ^{3}H(d,n)^{4}He, 25:59706
SIFFERT, P., Influence of trapping effects on Ge(Li) detector performance, 25:57798
  Ion implanted nuclear particle detectors, 25:57809
  Rectifying process in surface barrier detectors, 25:57741
  Temperature dependence of the average energy per electron--hole pair in germanium, 25:57739
SIIVOLA, A., Energy determinations of gamma rays and new weak transitions in decay of ^{56}Co, 25:59763
SIKA, J., Some remarks concerning zirconium alloy welding, 25:58188 (ZJE-110)
SILAEV, Yu. V., Optimization study of fast reactors, 25:60217
SILAR, Josef, Germanium based semiconductor detectors, 25:57730
SILIE, Control of an installation for the impregnation and gamma irradiation of wood, 25:57628
SILISTEANU, Ion, Leptonic decays of mesons, 25:59399
SILSBEE, R. H., Hindered rotation at 2°K of the NO_2 impurity in KCl, 25:59199 (NYO-2150-74)
SILVENNOINEN, P., Multigroup transport equation with a separable kernel, 25:59111
SILVESTER, P., Projective solution of integral equations arising in electric and magnetic field problems, 25:59214
SIMAKOV, A. S., Modified scalar potential in boundary-value problems in magnetostatics, 25:59647
SIMION, V., Absolute measurement of ^{239}Pu fission cross-section for 2200 m/sec neutrons, 25:59777 (IFA-NR-33)
SIMMONS, Guy H., Colloquium on nuclear medical technology training, Cincinnati, Ohio, 2/69, 25:60263 (BRH/DMRE-71-5)
SIMMONS, W. A., Implications of a charge asymmetry in ω^{0} Dalitz plot, 25:59468
SIMMONS, W. F., Nickel- and cobalt-base alloys, 25:58203
SIMOEN, J. P., Dosimetric characteristics of a Teflon--carbon mixture for the construction of cavity chambers for measurement of absorbed dose in the air, 25:57861
SIMON, J., Use of isotopes and radiation techniques in horticulture, 25:57911
SIMONENKO, D. L., α- and β-magnetic effects in homogeneous Ge monocrystals, 25:59143
SIMONSEN, H., Low-temperature irradiation facility for heavy-ion radiation damage studies of metals, 25:57620 (RISO-204)
SIMS, J. S., Ionosphere of Mars below 80 km altitude. II, 25:58676
SINANOGLU, O., Theory of electron correlation in ground and excited states with application to atomic properties, 25:58793
SINCLAIR, R. N., Studies of vibration spectra of bonded hydrogen atoms using a pulsed neutron source, 25:58384
SINCLAIR, W. D. J., Density changes in cladding materials irradiated in DFR, 25:58306
SINGH, B. P., Gamma transitions in ^{160}Dy, 25:59819
SINGH, Zorawar, Prog. rpt. on research in experimental and theoretical nuclear physics, annual, 7/15/71, 25:59841 (ORO-4119-1)
SINGHAL, R. P., Nuclear charge distributions of ^{89}Y, ^{90}Zr, and ^{92}Mo by elastic electron scattering, 25:59791
SINKEVICH, E. L., Surface waves in a magnetized plasma, 25:59092
SIROTKIN, A. M., Use of variational variable boundary functionals for constructing approximation methods for neutron transport theory, 25:59677
SISCOE, G. L., Empirical determination of aerodynamic factors for the magnetosphere, 25:58908
SISEFSKY, J., Debris over Sweden from the Chinese nuclear weapon test September 1969, 25:57580
SISEFSKY, Jan, Radioactive particles from eighth Chinese nuclear test, 25:57577
SISEVICH, I. G., System for automatic startup and power regulation of research reactors, 25:60169
SISSON, D. H., Liquid chromatography. I, 25:57526 (UCRL-73190(Rev.1))
SISTERO, R. F., UBV and Hβ photometry of eclipsing binary S Velorum, 25:58478
SIVA KUMAR, M., Void fraction measurements in two-phase

air-water flow in a vertical channel by gamma ray attenuation, 25:57648
SIVERS, Dennis Wayne, Physics of Regge trajectory with finite asymptotic phase, 25:59451
SIVJEE, Gulamabas Gulamhusen, Spectrophotometry of the night airglow and the aurorae, 25:58883
SKABICHEVSKAYA, G. I., Extraction of hafnium with cyclohexanone solution of thiocyanic acid, 25:57533
SKAKOV, Yu. A., Recrystallization and carbide phase formation processes in molybdenum base alloys, 25:58282
SKAKUN, N. A., Gamma-activation method for determining carbon and oxygen in beryllium, 25:57385
SKAVRONSKAYA, A. G., Influence of 5-bromouracil on sensitivity of Her^+- and Her^--bacteria to lethal and mutagenic effect of uv-light, 25:57965
SKIBENKO, A. I., Heating of a hot plasma created by an electron beam, 25:58972
SKIBENKO, E. I., Heating of a hot plasma created by an electron beam, 25:58972
SKIBENKO, K. P., Discriminatory development of alpha particle and proton recoil tracks in type K emulsion layers, 25:57731
SKIDMORE, M. R., Failure of aluminum tubing in the ORNL 86-inch cyclotron, 25:59643 (ORNL-TM-3523)
SKLAVENITIS, L., Dosimetric characteristics of a Teflon--carbon mixture for the construction of cavity chambers for measurement of absorbed dose in the air, 25:57861
SKLIZKOV, G. V., Investigation of the laser initiated discharge spark channel, 25:59076 (UCRL-Trans-10556)
SKOBLO, A. I., Reduction of uranyl ion by Ti(III) in nonaqueous media, 25:57415
SKREBTSOV, A. M., Method of investigating refractory wear in metallurgical furnaces with radioactive isotopes, 25:57677
SKRIPNIK, V. I., Kirkwood--Saltzburg equations for coefficient functions of scattering matrix, 25:59622
SKULSKI, L., Effect of a steady electric field on the diffusion of oxygen through polycrystalline layers of carbon or vanadium pentoxide, 25:58383
SKUMANICH, A., Application of generalized Newton--Raphson method in radiative-transfer problems, 25:59041
SKUPSKY, S., Radiative pion capture in ^{12}C, 25:59730
SLAGGIE, E. L., Prog. rpt. on fast reactor spectrum measurements, 5--7/71, 25:60156 (GULF-RT-A-10800)
SLATER, H. G., Public opposition to nuclear power: an industry overview, 25:60129
SLATER, J. C., Transition probabilities and fractional occupation numbers in atoms, 25:58718
SLATER, W. E., Rotation of symmetry axis in K-π scattering, 25:59502
SLAUS, I., Effects of the neutron pickup process on ^{3}He(p,pd)p quasi-free scattering, 25:59702
SLAVNOV, A. A., Invariant perturbation theory for nonlinear chiral Lagrangian, 25:59574
SLAVYAGIN, P. D., Comparison and analysis of the parameters of clinical whole-body spectrometers, 25:57823
SLEDZINSKA, I., Reactions ^{9}Be(d,α_0)^{7}Li (ground state) and ^{9}Be(d,α_1)^{7}Li* (470 keV), 25:59721
SLEE, O. B., Interstellar scattering and low-frequency spectrum of PSR 0833-45, 25:58540
SLEPCHENKO, L. A., Quasipotential formalism for the two-particle system with spins 0 and $^1/_2$, 25:59422 (JINR-E2-6046)
  Quasipotential theory of high-energy hadron scattering, 25:59442
SLESAREV, I. S., Use of variational variable boundary functionals for constructing approximation methods for neutron transport theory, 25:59677
SLETTEN, Geirr, Preparation of isotope targets by heavy-ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
  Preparation of targets of alpha-radioactive isotopes, 25:59638 (CONF-711002-, pp 116-21)
SLEZOV, V. V., Diffusion of substrate atoms into a surface film as indicated by the secondary ion--ion emission characteristics, 25:58266
SLOBODKINA, F. A., Stability of compression shock in magnetogasdynamic flows in channels, 25:58848
SMAKHTIN, L. A., Effect of slowing-down neutrons in the sample on the results of activation analysis, 25:57377
  Express determination of yttrium in rare earth concentrates by the method of activation with fast neutrons, 25:57382
  VVR reactor semiautomatic activation analysis system, 25:60168
SMALLMAN, R. E., Formation and behaviour of quenched-in voids in close packed metals, 25:58317
  Voids in intermetallic compound NiAl, 25:58318
SMELTZER, W. W., Comment on the defect structure and the transport properties of Nb_2O_5, 25:58391
SMETANA, Z., Magnetic transition points in U_3Bi_4 and UGa_2, 25:59190
SMEYERS, P., Second-order rotational perturbation of nonradial oscillations of a star, 25:58441
SMIRNOV, A. P., Nature of anomalies in resistive state of a superconductor, 25:58937
SMIRNOV, L. S., Luminescence of irradiated β-SiC, 25:59139
SMIRNOV, V. S., Search for $\pi^+ + e^+ + \nu$/sub e/ + $e^+ + e^-$ decay, 25:59255 (BNL-tr-451)
  Search for the decay $\mu^+ + e^+ + e^+ + e^-$, 25:59254 (BNL-tr-449)
SMIRNOV, Yu. A., Determination of the oxygen content in metallic ruthenium, 25:57329
SMIRNOVA, N. M., Ion exchange fibers and fabrics. II, 25:57555
SMITH, Bart Alan, Nuclear fuel retainer, 25:60246
SMITH, F. G., Characteristics of the radio pulses from the pulsars, 25:58545
SMITH, Frank R., Hydrogen/deuterium separation factors on cathode and diffusion sides of 25 percent Ag--Pd foils, 25:57538
SMITH, J., Intermediate boson. II, 25:59410
  Neutral kaon decays into muon pairs and violation of CP invariance, 25:59544
  Production of single W bosons in electron--positron colliding beams, 25:59383
SMITH, R. Connon, Importance of circulation in radiative stellar envelopes, 25:58518
SMITH, R. J., Observations on particulates in a sodium loop, 25:58170 (RD/B/N-1998)
SMITH, R. W., Classification of the indium--zinc eutectic, 25:58286
SMITH, S. Vaughan, Variations in the relationships between total ^{59}Fe uptake and heme and nonheme fractions of spleen and bone marrow in irradiated mice and mouse radiation chimeras, 25:58119
SMORODINSKII, Ya. A., Transformation properties of states at infinite momentum II, 25:59321 (JINR-E2-5993)
SNIDER, M. A., Synthesis of fast reactor neutron energy spectra, 25:60215
SNIPES, M. B., Resolution of two β-emitting radionuclides by liquid scintillation counting, 25:57353
SNOVER, K. A., Symmetry energy for collective dipole excitation, 25:59742
SNOW, K. B., Comparison of paints by neutron activation analysis. II. Colored paints, 25:57373
SNYDER, R., Formula for relativistic atomic energies, 25:58819
SOARES, J. C., Fluorescence, Auger, and Coster--Kronig L/sub II/ subshell yields of Th, 25:58719
SOBICZEWSKI, A., Theoretical estimates of lifetimes of superheavy nuclei, 25:59803
SOBOLEVSKII, N. M., Interaction of high-energy radiation with matter, 25:59508 (ORNL-tr-2514)
SOBOTTKA, S., Cross sections for (π^+,p) reactions on ^{9}Be, ^{12}C, and ^{16}O, 25:59710 (LA-DC-12781)
  New measurements of (π^+,2p) reactions on light nuclei, 25:59709 (LA-DC-12389)
SOERAAS, F., Variations in high-latitude proton trapping boundary, 25:58866
SOERENSEN, H., Low-temperature irradiation facility for heavy-ion radiation damage studies of metals, 25:57620 (RISO-204)
SOKOLIC, A., Immunity developed in chickens using irradiated eggs, 25:57946
SOKOLOV, A. D., Sensitive element for radiothermoluminescent dosimeters for gamma and neutron radiations, 25:57849
SOKOLOV, I. N., Hydrodynamic problems of vessel-type boiling-water reactors, 25:60065
SOKOLOV, L. D., Study of hardening during fatigue of various pure metals, 25:58223
SOKOLOV, V. B., Krypton difluoride, 25:57455
SOKOLOVA, I. A., Preparation of gas samples from carbonates and their solutions for measurements of activity of ^{14}C, 25:57358
SOKOL'SKII, A. A., Differential Lie and test relativistic particles, 25:59584
SOKOL'SKII, D. V., Effects of nuclear radiation on the activity of a palladium catalyst for the hydrogenation of butynediol, 25:57448
SOLDANO, B. A., Utility of ice cubes as an absorbent for gaseous fission products, 25:60124
SOLIMENO, S., Equation of motion for P representation, 25:59208
SOLONOVICH, V. F., Successive determination of uranium and thorium in oxides of the rare earth elements, 25:57341
SOLOV'EV, M. M., Protection against reactor emergencies associated with reactivity perturbations, 25:60123
SOLOV'EV, V. G., Theory of complex nuclei, 25:59875
SOLTAN, A. Jr., Measurement of γ-ray spectra accompanying radiative capture of nucleons, 25:59801
SOLTYS, T. J., High purity germanium for detector fabrication, 25:57787
SOMA, Y., γ-radiolysis of gaseous carbon dioxide at high densities, 25:57461
SOMASUNDARAM, S., IAEA international glass dosimetry intercomparison, 1970, 25:57838
SOMERVILLE, W. B., Extension of the Hylleraas expansion for the helium ground state, 25:58795
SOMMERFELDT, H., Amorphization of crystals by ion bombardment and mechanisms of secondary processes, 25:59175
SOMOV, A. I., Recrystallization of copper reinforced with tungsten, 25:58285
SONNABEND, E., X-ray dose to the patient in maxillodental tomography, 25:58022
SONREL, Jean, Development of sequential automation of third unit of Chinon nuclear power station, 25:59894
SOOD, P. C., Binding energies of alpha-particle nuclei, 25:59725
SOOST, H.-J., Influence of adrenal cortex total extracts on radiation sickness, 25:58035

SORACE, E., Realization of chiral symmetry in meson states through SU(4) x O(3), 25:59551
SOROKIN, M. N., Investigation of ternary solid solutions Ni$_3$(Fe,V), 25:59188
SORRIAUX, Andrea, Study of electrical conductivity and thermoelectric power of uranium dioxide UO/sub 2+x/ at high temperatures, 25:59191
SOTIROVSKI, P., Isotopes of magnesium in the solar atmosphere, 25:58597
SOTIROVSKII, P., Molecular spectrum of sunspot umbrae, 25:58577
SOTNIKOVA, V. S., Influence of various carriers in the spectrographic analysis of oxides of refractory metals (tungsten and zirconium), 25:57335
SOTTO, M. F., Cellular ultrastructure and mitotic index of lymphocytes of leukemia during treatment by irradiation, 25:58131 (CEA-CONF-1768)
SOUFFRIN, S., Optical line spectrum of a gas heated by hard uv radiation or energetic particles, 25:58629
SOULEN, Robert J. Jr., Equivalence of the superconducting transition temperature of pure indium as determined by electrical resistance, magnetic susceptibility, and heat-capacity measurements, 25:58949
SOWARD, A. M., Nearly symmetric kinematic and hydromagnetic dynamos, 25:58846
SOYTUERK, E., Relation between electric conductivity in faculae and in Bilderberg model of photosphere, 25:58588
SPAULDING, M. B., Study of the reticuloendothelial system in hematological diseases, 25:58053
SPEAR, R. H., Magnetic analysis of reactions ^{7}Li(^{3}He,d)^{8}Be and ^{7}Li(^{3}He,t)^{7}Be, 25:59731
  Search for high-spin states in ^{27}Al, 25:59761
SPECTOR, N., 4 f--5 d interactions in Sm, Gd, and Tb, 25:58697
SPECTOR, Nissan, Congigurations 4f/sup N-1/6s^{2}6p in Gd, Dy, Er, and Yb, 25:58706
SPEKTOR, A. Ts., Influence of yttrium on the phase composition of vanadium--gallium alloys, 25:58289
SPENCER, Russell Boone, Measurement of photon induced high energy secondary electron emission, 25:59107
SPERDUTO, A., Highly excited states seen in reaction ^{12}C(^{16}O,p)^{27}Al, 25:59714
SPERINDE, Johnie M., Self-triggered wire chambers for radiation imaging purposes, 25:57784
SPEVACEK, V., HMO estimation of iodine exchange rates between substituted aryl iodides and alkali iodides, 25:57425
SPIERS, F. W., Radiation units and the measurements of ionizing radiation, 25:58002
SPINRAD, Hyron, Evolution of M31 disk population, 25:58491
SPIRIDONOV, V. B., Recrystallization and carbide phase formation processes in molybdenum base alloys, 25:58282
SPYRA, Wolfgang, Powder metallurgical production of neutron-absorber units for nuclear reactors, 25:58255
SQUIRES, E. J., Exciting world of hadron physics, 25:59326
SREBRO, Z., X-ray induced increase in number of cysteine-rich periventricular glial cells in the rat brain, 25:58106
SREEKANTAN, V., Ratio of pions to protons and ratio of neutral-to-charged interacting particles at 800 gm/cm^{2}, 25:58834
SRIKANTIAH, G., Void fraction measurements in two-phase air-water flow in a vertical channel by gamma ray attenuation, 25:57648
SRINIVASAN, G. R., Nuclear-particle track detection using liquid--liquid phase separation: the glass chamber, 25:57727
SRINIVASAN, M. R., Construction problems at Kalpakkam, 25:59892
SRINIVASAN, R., ESR study of vanadyl ion in irradiated vanado complex, 25:57449
SROCZYNSKA, Magdalena, Observational data on the solar wind, 25:58585
SROMOVSKY, Lawrence Anthony, Regge pole analysis of glory scattering, 25:59846
STAFFORD, Richard David, Nucleon--nucleus inelastic scattering with realistic nucleon--nucleon interactions, 25:59858
STAHEL, E. P., Radiation induced ionic polymerization, 25:57450 (ORO-3667-1)
STAKHOV, O. V., Nutation NMR stabilizer for beta-spectrometer magnetic fields, 25:57824
STALS, L., Recovery of rhenium following low-temperature alpha-particle irradiation, 25:59142
STAMATOVIC, A., Significance of energy resolution in electron--atom and electron--molecule collisions, 25:58747
STAMM, W., Electromagnetic interactions of high-energy cosmic-ray muons, 25:59246
STANFORD, J. F. Jr., Velocity cross section 5, extending southwest from Tatum dome, Lamar County, Miss, 25:57595 (USGS-474-112)
STANFORD, John F. Jr., Structure of the southeastern Mississippi region, 25:57596 (USGS-474-129)
STANKOVIC, Caslav, Behavior of concrete reactor vessels at raised temperatures and solution of the thermal protection, 25:60081
STANNETT, V., Radiation induced ionic polymerization, 25:57450 (ORO-3667-1)
STANOLOV, A., Note on the determination of neutron diffusion constants, 25:59687
STARCHIK, L. P., Neutron activation analysis of enriched isotopes of Eu, In, Ir, and Lu, 25:57391
  Use of (p,γ) reaction to determine light-element content in thin surface layers, 25:57396
STARTZNYI, E. S., Effect of slowing-down neutrons in the sample on the results of activation analysis, 25:57377
STAROZHITSKAYA, M. I., Separation of Pt from daughter isotope of Au, 25:57554
STARR, V. P., Eddy viscosity and the solar rotation, 25:58622
STARTSEV, V. I., Electron deceleration by dislocations in Type-II superconductors, 25:58932
STASCHEWSKI, Dieter, Extensive enrichment of stable oxygen isotopes by countercurrent distillation of heavy water, 25:57675
STATELOV, V., Use of chromosome analysis for biological dosimetry in connection with an accident involving ^{226}Ra, 25:58016
STAUFFER, Henry Hans, Effect of O on somatic crossing over in X-chromosome of Drosophila melanogaster, 25:57959
STAVITSKII, R. V., Investigation of buildup region for γ-radiation from low-level sources, 25:59120
STAVROPOULOS, G. P., Ionic transport numbers of group IIa oxides under low oxygen potentials, 25:58379
STECH, Berthold, Violation of ΔI absolute value = $^{1}/_{2}$ rule in non-leptonic decays, 25:59405
STEELE, J. H. Jr., Microradiographic study of fracture in boron filament--aluminum matrix composite, 25:58400
STEFAN, H., Program for the computing of the scattering cross-sections in heavy water, 25:59671 (IFA-DNBR-3)
  Riva--Butler's code, 25:59689
STEFANIK, J., Intercomparison measurements of SKODA and INR calorimeters on EWA-10 reactor, 25:57875 (INR-1319)
STEIGMAN, G., Ultradense matter, 25:58432
STEIN, H. J., Defects in silicon: concepts and correlations, 25:59135
STEIN, P. C., Branching ratio for decay of phi mesons into lepton pairs, 25:59310
STEIN, W. A., Photometric measurements at lambda = 11 μ m of NGC 4151, 25:58654
  Search for interstellar silicate absorption in spectrum of VI Cyg No. 12, 25:58512
STEINBERG, M., Experimental work in the Brookhaven Chemonuclear In-Pile Research Loop, 25:57610 (BNL-50293)
STEINBOCK, P., Economic characteristics for fuel consumption in nuclear power stations, 25:60102
STEINDLER, M. J., Chemical Engineering Division fuel cycle technology quarterly report, January--March 1971, 25:57507 (ANL-7799)
STEINITZ, Robert, Cobalt-rich ductile permanent magnet alloys with molybdenum additions, 25:59197
STELTS, Marion L., Spectra of fast neutrons from water pulsed with 14-MeV neutrons, 25:59674
STENERSON, R. O., Phenomenology of muon showers underground, 25:59247
STENING, Robert J., Characteristics of irregular micropulsations Pi2 at high-latitude stations, 25:58903
STEPAN, O., Influence of ionizing radiation on the catalytic activity of iron catalysts for ammonia synthesis, 25:57444
STEPANOV, A. V., Thin-layer electrophoresis in inorganic analysis. I, 25:57299
STEPHENS, F. S., E4 moments in ^{152}Sm and ^{154}Sm, 25:59823
STEPHENSON, J. M. Jr., Accelerator instrumentation and control system using CAMAC, 25:59664
STEPIEN, Kazimierz, Atmospheres of pulsating stars, 25:58485
STEPIEN-RUDZKA, W., Theoretical estimates of lifetimes of superheavy nuclei, 25:59803
STEPIN, V. V., Use of ion-exchange chromatography in determination of vanadium in ferrovanadium and iron ore, 25:57339
STERLINI, Jacques, MHD power plant using a liquid metal emulsion, 25:58841
STERN, Marvin J., Relative tritium--deuterium isotope effects in the absence of large tunneling factors, 25:57430
STERNBERK, J., Magnetic transition points in U$_3$Bi$_4$ and UGa$_2$, 25:59190
STEVANOVIC, M., Contribution to effect of gas pressure in pores on boundary migration and grain growth in sintered UO$_2$, 25:58408
STEVENS, J. W., Transient film and transition boiling from a sphere, 25:57642
STEVENS, P. N., Experimental investigation of neutron streaming through the grid-plate shield of the fast flux test facility, 25:60158 (ORNL-TM-3514)
STEWART, J. M., Qualitative cosmology, 25:58669
STICKLAND, David J., Energy distributions of main-sequence stars, 25:58517
STIEGLER, J. O., Void formation in neutron irradiated metals, 25:58299 (ORNL-TM-3495)
STIEGLER, James O., Study of the formation of creep cavities in powder-metallurgy tungsten, 25:58213 (ORNL-TM-3350)
STIEVE, F. E., Automatic exposure in tomography, 25:58066
STIRBA, Alois, New power supply equipment for 28-GeV CERN proton Synchrotron, 25:59662

XUM

STIRLING, C., Liquid scintillation counting of ^{45}Ca in soft tissues, 25:57361
STOKER, P. H., Rigidity dependence of Forbush decreases and 11-year variation in cosmic-ray intensity, 25:58823
STOKES, Richard H., Determination of ^{12}Be ground-state mass, 25:59716
STOLARIK, J. D., Rocket measurements of magnetic fields associated with visual aurorae, 25:58857
STOLL, Howard L. Jr., Tumors of skin. XII, 25:58037
STOLLAROVA, N., Separation of radioiodide from simulated biological samples by isotopic exchange in a heterogeneous system, 25:57367
STOLT, R. H., Parastatistics with variable numbers of particles, 25:59561
STOLYAROVA, E. L., Dosimetric characteristics of silicon detectors for gamma radiation, 25:57850
  Spectrometric characteristics of germanium detectors with radiation defects, 25:57822
STONEHAM, A. M., Theory of defects in irradiated semiconductors, 25:59131
STONEHAM, Thomas Ash, Precise measurements of W, mean energy expended per ion pair formed in alkane vapors and in Ar, 25:59122
STOREY, O., Possibility of using a quadrupole probe for measuring electric currents in the magnetosphere, 25:58885
STOREY, Owen, Double microfield probe, 25:58990
STORROW, J. K., Veneziano model and unitarity sum rules, 25:59462
STOTLAND, M. A., Influence of high-frequency potential of toroidal electric field on the trapping of charged particles in a closed magnetic trap, 25:58976
STRAIN, C. V., Activation analysis of sodium and potassium in solid propellants, 25:57384
STRAIN, R. V., Experimental irradiations of fuel elements having known cladding defects in EBR-II, 25:60082 (ANL-7782)
STRAKA, R. M., Mapping of solar polarization at 7.8 GHz, 25:58620
STRAUSS, M. G., Computer controlled CAMAC systems at Argonne, 25:57884
STREETER, Gary, Low power charge sensitive amplification and fast coincidence system for space application, 25:57821
STREIFF, R., Comment on the defect structure and the transport properties of Nb_2O_5, 25:58391
STRELKOV, L. A., Oxidation and dissolution of U compounds in nonaqueous media. II, 25:57548
  Oxidation and dissolution of U compounds in nonaqueous media. I, 25:57547
STREL'TSOVA, S. A., Determination of Eu, Tb, Sm, and Dy in optical fluorite, 25:57332
STREMNITZER, H., Non-local effects in the decay of polarized muons, 25:59404
STRITTMATTER, P. A., Counts of sources and theories, 25:58659
STROGONOV, Yu. D., Effect of nitriding on the properties of tantalum, 25:58259
STROTTMAN, D., Low lying 8 and 12 hole states in light nuclei, 25:59757
STROUD, P. T., Preferential deposition of thin silver films induced by electron bombardment, 25:58178 (AWRE-O-42/71)
STRYCZNIEWICZ, K., Levels of ^{230}Th and ^{230}U fed in decay of ^{230}Pa, 25:59800
STUART, J. P., Compton and Rayleigh scattering of x rays by heterogeneous materials, 25:59118
STUCK, R., Temperature dependence of the average energy per electron--hole pair in germanium, 25:57739
STUDENSKAYA, L. S., Use of ion-exchange chromatography in determination of vanadium in ferrovanadium and iron ore, 25:57339
STUDIER, Martin H., Origin of organic matter in early solar system. IV, 25:58576
STUMER, Iuliu, Evaluation of low-energy ΣN interaction parameters, 25:59525
STURROCK, P. A., Longitude distribution of solar flares, 25:58570 (N-71-14166)
STUTZ, E., Tumors of albino rats of various ages after single total-body roentgen irradiation, 25:58097 (ORNL-tr-2521)
STUY, Johan H., Prog. rpt. on cell response to penetration by nucleic acid, annual, 9/70--8/71, 25:60282 (ORO-3885-3)
STVERAK, B., Influence of ionizing radiation on the catalytic activity of iron catalysts for ammonia synthesis, 25:57444
SUBBARAYA, B. H., Electrostatic plasma instabilities in the equatorial electrojet, 25:58900
SUBRAMANIAN, A., Ratio of pions to protons and ratio of neutral-to-charged interacting particles at 800 gm/cm^2, 25:58834
SUBRAMANIAN, C. K., ESR study of vanadyl ion in irradiated vanado complex, 25:57449
SUBRAMANIAN, Carole, Fatty acid transport into the brain, 25:60290 (UCLA-12-839)
SUBRAMANIAN, R. V., Prog. rpt. on polymer grafting to inorganic substrates, annual, 2/1/70--1/31/71, 25:58416 (RLO-2098-2)
SUCHKOV, A. B., Activity of Al, V, and Cr in binary Ti alloys, 25:58220
SUDA, Nobuhide, Estimation of reactor parameters by optimal filtering method, 25:60234
SUGAHARA, Tsutomu, Radiation and chromosomal abnormality, 25:57963
SUGAI, Isao, Alpha-ray thickness gage. II, 25:57864 (INS-TL-112)
SUGANEEV, Yu. S., Thermophysical properties of yttrium above 20°C, 25:58225
SUGANO, Reiji, Consistency between Lagrange and Hamilton formalisms in quantum mechanics, 25:59558
SUGIER, H., Role of the external surface of crystalline alkali halides in radiation induced chemical decomposition, 25:57464
SUGLOBOV, D. N., Reduction of uranyl ion by Ti(III) in nonaqueous media, 25:57415
SUJKOWSKI, Z., Relative K-capture probability in unique first-forbidden decay of ^{145}Sm, 25:59799
SUKHANOVA, G. A., Radon irradiation of rat tissue and organs, 25:57932
SUKHORUCHKIN, S. I., New data of differential measurements of ratio α for ^{239}Pu, 25:59812
SUKHOV, G. V., Express determination of yttrium in rare earth concentrates by the method of activation with fast neutrons, 25:57382
SUKROW, S., Complex automation of nuclear power plants, 25:60048
SUKSOV, I. I., Calculation of the characteristics of stabilized electric arc heating of gases at high pressures, 25:59059
SULABERIDZE, G. A., Study of effective nonsymmetric multicomponent isotope separation cascades, 25:57670
SULIK, A., Excitation of isomeric activities in Rb, Y, Pd, Cd, W, Os, and Pb using 14.8-MeV neutrons, 25:59797
SUL'KIN, A. G., Optimal time of using a radioisotope source of radiation in nondestructive testing, 25:57697
SULLIVAN, Edmund Joseph Jr., Investigation of charge-symmetry-breaking in lambda--nucleon interaction, 25:59515
SULLIVAN, J. D., Vector-meson dominance model and inelastic electron--proton scattering, 25:59365
SUMARUKOV, G. V., Sterilizing doses of x-ray for rice and granary weevil, 25:58161
SUN, K. H., Incore detector for measuring power and breeeding distributions in power breeders, 25:60050
SUNAYASHIKI, Tadashi, Dose estimation in tangential radiation therapy, 25:58003
  Dosimetry of x-rays, gamma-rays, and neutrons with ferrous sulfate solution, 25:57862
SUNTA, C. M., Effects of residual thermoluminescence in fluorite and lithium fluoride thermoluminescent dosimeters, 25:57844
SURGAILENE, R. T., Theoretical calculation of energy levels for rare earth element ions, 25:58709
SUSCILLON, M., Cellular ultrastructure and mitotic index of lymphocytes of leukemia during treatment by irradiation, 25:58131 (CEA-CONF-1768)
SUTHERLAND, Bill, Exact results for a quantum many-body problem in one dimension, 25:59230
SUTTER, Erich Erwin, Wave mechanical interpretation of free quantized fields with the help of clifford algebras and an outline for a wave mechanical theory of interactions, 25:59563
SUTTON, J., Accurate radio and optical positions of 3C 273B, 25:58566
SUVOROV, A. L., Adsorption and desorption of residual gases on a tungsten surface in a strong electric field, 25:58246
SUVOROV, A. M., Zone liquation in niobium alloy ingots obtained by electronic melting, 25:58260
SUZUKI, Atsuyuki, Application of linear programming to refueling optimization for light water moderated power reactors, 25:60104
SUZUKI, Masao, Fission track ages and uranium contents of obsidians, 25:57569
SUZUKI, Masashi, Final report of research project on plutonium hazards, 4/66--3/70, 25:57998 (NIRS-Pu-8)
SUZUKI, Takashi, Positive scintiphotography of cancer of the liver with ^{67}Ga citrate, 25:58045
SUZUKI, Toshimitsu, Performance of clinical linear accelerator, 25:59661
SUZUKI, Tsuneo, Chiral invarient Lagrangian with massive gauge fields, 25:59449
SVECHNIKOV, V. N., Influence of yttrium on the phase composition of vanadium--gallium alloys, 25:58289
SVENNE, J. P., Compressibility under deformation of the nuclear Hartree--Fock field, 25:59877
SVET-MOLDAVSKAYA, I. A., Morphological study of organs, blood cells, and bone marrow of white rats and mice with vaccinal disease, 25:58128
SVITEL, J., Use of Ross filters in radioisotope x-ray fluorescence determination of iodine in drugs, 25:57322
SVOBODOVA, J., Fast preparation method of ^{32}P applicators, 25:57500
WANSON, J. L., Destruction of nitrous acid and hydrazoic acid in purex systems, 25:57511 (BNWL-B-121)
SWANSON, M. L., Damaged regions in neutron-irradiated and ion-bombarded Ge and Si, 25:59140
SWART, Hans, Exposure to radiation in orbital flights, 25:58025 (ORNL-tr-2490)
SWARUP, G., Lunar occultation observations of 25 radio sources, 25:58538

SWIGON, K., Isotopic method for determining the efficiency of equipment for agglomerate production, 25:57659
SWINEHART, C. F., Barium fluoride as a gamma ray and charged particle detector, 25:57817
SWINGS, P., Phenomena of fluorescence in stars, 25:58519
SWITZER, P., Longitude distribution of solar flares, 25:58570 (N-71-14166)
SWORZECKA, M., Binding energy of ^{3}H and n--d doublet scattering length with rank-four separable potential, 25:59707
SYMONS, M. C. R., Initial fate of hydrogen atoms and hydroxyl radicals in the radiolysis of frozen aqueous solutions of alkali halides, 25:57467
  Unstable intermediates. XCVIII, 25:57445
SYNEK, M., Accurate analytical self-consistent-field wave functions for Dy^{2+}, 25:58698
SYSA, Andrzej, Influence of uv radiation on pigeon erythrocytes, 25:58113
SYSA, Jozef, Influence of uv radiation on pigeon erythrocytes, 25:58113
SYUNYAEV, R. A., Are quasi-stellar objects the nuclei of embryonic galaxies, 25:58626
  Low-frequency spectrum of radio sources, 25:58527
SZCZEPANIKOWSKI, J., Relative K-capture probability in unique first-forbidden decay of ^{145}Sm, 25:59799
SZEFLINSKI, Z., Measurement of γ-ray spectra accompanying radiative capture of nucleons, 25:59801
SZEGO, K., Use of negative time-like states, 25:59609 (KFKI-71-39)
SZTEKE, Witold, Possible uses of plasma in powder metallurgy, with particular reference to spheroidization, 25:58187 (SCL-T-710281)
SZUDY, J., Franck--Condon principle and broadening of isolated spectral lines in plasmas, 25:59032
SZUSZCZEWICZ, E. P., Behavior of low-density plasma in presence of cylindrical Langmuir probes, 25:58999
SZYSZKO, Edmund, Changes of Dextran 40000 irradiated with γ radiation, 25:58160

T

TABOR, S. L., Elastic scattering of 5- to 10-MeV protons from aligned ^{165}Ho, 25:59788
TACHIMORI, Syoichi, Preparation of /sup 99m/Tc by direct adsorption from organic solution, 25:57483
TACHON, J., Plasma confinement in the DECA II B circularized magnetic well, 25:58958 (CEA-CONF-1807)
TADEMARU, E., Pulsar radio emission from expanding charge sheets, 25:58549
TAFF, L. G., Small clusters of galaxies and the mass-to-light ratio, 25:58643
TAIEB, Control of an installation for the impregnation and gamma irradiation of wood, 25:57628
TAKAHASHI, Hiroshi, Combining lower- and higher-order discrete-ordinate approximation to transport equation, 25:59680
TAKAHASHI, Ichi, Electron microscopic study of radiation effects on cultured cells with different radiosensitivities, 25:58085
TAKAHASHI, Kohji, Gross theory of first forbidden β-decay, 25:59868
TAKAHASHI, Y., Crystal structure of graphite bromine lamellar compounds, 25:58404
TAKANO, H., Benchmark test by various cross section sets for fast reactor analysis in Japan, 25:60210 (JAERI-Memo-4406)
TAKANO, Shigeo, Electron microscopy of hydride precipitation in vanadium, 25:58407
TAKASHIMA, Yoshie, Performance analysis of BWR emergency core cooling system designed for Shimane nuclear power station of Chugoku Electric Power Company, 25:59897
TAKATS, Martha Carroll, Experimental study of Dalitz plot in decay K/sub L/^{0} → $\pi^+ + \pi^- + \pi^0$, 25:59258
TAKATSUJI, Kazuhiko, Separation factors in a europium chloride--samarium chloride--neodymium chloride--di(2-ethylhexyl)phosphoric acid system, 25:57543
TAKAYAMA, Hajime, Dynamical fluctuation of order parameter and diamagnetism of superconductors. I, 25:58945
  Higher order effects due to superconducting fluctuation on electrical conductivity, 25:58930
  Superconducting fluctuation effects on the S-I-N junction current, 25:58936
TAKEDA, Susumu, High density theta-pinch plasma pre-ionized by shock wave, 25:59056
TAKEDA, T., Aspect of plasma diffusion in multipoles, 25:58970
  Measurement of the plasma current distribution in a tokamak device with alpha-particles injected transverse or parallel to the toroidal axis, 25:58980 (JAERI-Memo-4531)
TAKEDA, Toshikazu, Improvement to the calculation of collision probabilities in annular system and its application to cluster geometry, 25:60235
TAKEI, Mitsuo, Nuclear power as source of energy in Japan, 25:59928
TAKENAKA, Yutaka, Examples of stress analysis of structures by finite element method, 25:60142
TAKESHITA, Kenji, Dose estimation in tangential radiation therapy, 25:58003
TAKETANI, Kiyoaki, Uranium dioxide fuel pin elongation behavior under irradiation, 25:58414
TAKEUCHI, Hajime, Pitch-angle distribution of fast electrons, 25:58904
TAKITA, Y., Some experimental data conflicting with the explosion model in gaseous bromides, 25:57501
TAKSIS, G. A., Making heating elements on the basis of zirconium dioxide for high-temperature furnaces, 25:58357
TALLEY, Wilson K., Device and method using gamma rays for size and density produce selection, 25:57871
TALON, R., Extraterrestrial γ-ray contribution between 0.7 and 4.5 MeV, 25:58832
TALWAR, S. P., Electrohydromagnetic instability of superposed fluids, 25:58842
TAMAI, Tadaharu, Rapid separation of fission-product rare earths and yttrium by electromigration, 25:57558
TAN, Hing-tat, Sum rules for effective interactions between ^{3}He quasi particles in superfluid ^{4}He, 25:58924
TANABE, R., Axial vector form factor of the nucleon and the quark--parton model, 25:59391
TANAKA, Eiichi, Final report of research project on plutonium hazards, 4/66--3/70, 25:57998 (NIRS-Pu-8)
TANAKA, M., Aspect of plasma diffusion in multipoles, 25:58970
TANAKA, S., Production of ^{26}Al and ^{22}Na, 25:59753
TANATAROV, L. V., Diffusion of substrate atoms into a surface film as indicated by the secondary ion--ion emission characteristics, 25:58266
TANDON, A. N., Progress of seismology in India, 25:57591 (INIS-mf-71, pp 181-98)
TANDON, S. P., Effect of rare elements on nitrification in soil suspension, 25:57401
TANGE, Toshio, Relaxation of difference between ion and electron temperatures in a plasma, 25:59028
TANIKAWA, Yasutaka, Lepton--baryon resonances and duality in weak processes, 25:59395
TAPLIN, George V., Comparison of radioaerosol versus radioxenon inhalation procedures in obstructive lung disease and pulmonary embolism, 25:58040 (UCLA-12-834)
TARANDI, Taivo, Pre-stressed concrete pressure vessel, 25:60069
TARASEVICH, S. V., Reaction $\pi^- p$ → etan and universality of complex trajectories, 25:59479
TAROLO, G. L., Use of radioactive tracers in the study of breast cancer, 25:58051
TARTAGLIA, N. A., Conjugate geomagnetic studies near the plasmapause, 25:58898
TASAKI, Ichiji, Effects of ultraviolet and visible light on nerve fibers and changes in optical properties during nervous activity, 25:57942
TASHJIAN, B. M., Sensitivity analysis of a two-out-of-four coincidence logic reactor protective system, 25:60052
TATARU, E., Proton magnetic resonance study on light- and heavy-water solutions of Be(II), 25:57429
TATSUNO, Ikuro, New agent for liver scanning, 25:58050
TAUBIN, M. L., Thermophysical properties of yttrium above 20°C, 25:58225
TAUMANN, L., Computer program for determination of isodose curves for electron energies from 5 to 42 MeV, 25:58009
TAVKHELIDZE, A. N., Quasipotential theory of high-energy hadron scattering, 25:59442
TAYLOR, A. J., Pyrolytic carbon infiltration studies, 25:58352 (Y-DA-2123(Rev.1))
TAYLOR, Denis, Radio-isotope instrumentation, 25:57868
TAYLOR, Harold E., Nonadiabatic behavior of radiation-belt particles, 25:58907
TAYLOR, J. C., Soft pion--pion scattering to fourth order in momenta and effective chiral Lagrangians, 25:59455
TAYLOR, J. R., Parastatistics with variable numbers of particles, 25:59561
TAYLOR, M. R., Classification of the indium--zinc eutectic, 25:58286
TAYLOR, Richard E., Log of Hydrologic Test Well 1, Tatum dome area, Lamar County, Mississippi. Dribble-6, 25:57562 (USGS-474-110)
  Log of Hydrologic Test Well 2, Tatum dome area, Lamar County, Mississippi. Dribble-7, 25:57563 (USGS-474-111)
TAZAWA, Hisashi, Energy levels of ^{142}Nd, 25:59821
TEATHER, G. G., Optical measurements on solvated electrons in pulse-irradiated liquid propane, 25:57468
TEDROW, P. M., Direct observation of spin-state mixing in superconductors, 25:58943
TEICHMANN, J., Dielectric properties of plasma penetrated by the helicon wave and its influence on microinstabilities in the case of anisotropic ion temperatures, 25:59083 (CEA-CONF-1826)
TEIXEIRA, J. M., Measurement device and numerical analysis of electrical resistivity from 4 to 300°K. Application to Nb--Hf alloys, 25:58929 (FRNC-TH-72)
TEJNECKY, M., Partition chromatography of uranium and fission products on porous styrene-divinylbenzene copolymer swollen in the solution of tributylphosphate. III, 25:57527 (UJV-2557-Ch)
TELLO R., Carlos, ^{75}Se-selenomethionine in scintallography of thyroid and hepatic lesions, 25:58054
TENNANT, William E., Impedance matching Josephson galvanometer by means of superconducting transformer, 25:58938
TEPLOVA, Ya. A., Electron loss and capture cross sections for multiply charged ions in solid matter, 25:58695

XUM

TER-ANTONYAN, V. M., Deep inelastic electroproduction of hadrons on a photon target, 25:59333 (JINR-E2-6036)
TERASHIMA, Y., Stochastic model of electron-cyclotron heating in a magnetic mirror, 25:58968
TEREKHOVA, V. F., Alloys of yttrium with dysprosium and holmium, 25:58274
TEREN, S., Intercomparison measurements of SKODA and INR calorimeters on EWA-10 reactor, 25:57875 (INR-1319)
TERENT'EV, M. V., Possible connection between amplitudes of processes $e^+e^- \to 3\pi$, $\gamma\gamma \to 3\pi$, and $\pi^0 \to 2\gamma$, 25:59357
  Two-photon generation mechanism in the collision of charged particles, 25:59370
TERPUGOV, V. G., Formation of braking radiation beam of medical betatron, 25:59651
TERSKII, R. V., Detection of defects in butt welds with beta rays, 25:57700
TESCH, S., Determination of the neutron--neutron scattering length from a kinematically complete experiment with the reaction ^{3}H(t,n^{4}He)n, 25:59506 (JINR-E15-5905)
TESKE, Richard G., Soft solar x rays and solar activity. V, 25:58600
TESTA, C., Radiotoxicological analyses used at CNEN, 25:57347 (RT/PROT-(71)9)
TESTA, M., Observations on production of hadrons by means of Landau--Lifshitz process, 25:59334 (LNF-71/14)
TESTE DU BAILLER, A., Saint-Laurent I fuel melt down incident, 17 Oct 1969, 25:59924
TETENYI, P., Isotope effect study in catalytic exchange of ethane, 25:57428
TETYUEVA, T. V., Effects of thermal cycling of monocrystals of tungsten--molybdenum alloys, 25:58247
TEUBNER, P. J. O., Lyman-alpha emission induced by the collisions of electrons with molecular hydrogen, 25:58729
TEVEBAUGH, A. D., Prog. rpt. on physical chemistry of liquid metals and molten salts, semiannual, 1--6/71, 25:58387 (ANL-7823)
THAKUR, M. L., ^{52}Fe: improving its recovery from cyclotron targets, 25:57486
THEISS, S., Aqueous reprocessing of fast breeder fuel elements, 25:57518 (EURFNR-888)
THEODORESCU, M., Effect of x irradiation of the head on neurosecretory cells in Gryllus domesticus L, 25:58095
THIELE, Everett, Collision of an atom and a diatomic, 25:58761
  Reaction matrix method for computing probabilities of vibration--translation energy transfer, 25:58762
THIESSEN, Joop W., Regional approach to the management of radiation accidents, 25:58039
THOMAS, Brian K., Glauber amplitudes in charged-particle--hydrogen-atom collisions, 25:58766
THOMAS, G., Dislocation contrast at high voltages, 25:60292 (UCRL-20700)
  Heterogeneous dislocations in GaAs, 25:60291 (UCRL-20525)
THOMAS, J., ^{226}Ra activity determination in non-equilibrium state by scintillation gamma spectrometry, 25:57365
  Evaluation method of the gamma spectrometrical determination of radium in state of non-equilibrium, 25:57506
THOMAS, R. M., Spectrum and galactic isotropy of diffuse cosmic x rays, 25:58650
THOMAS, Richard N., Solar spicules and chromospheric heating, 25:58619
THOMAS, W. E., Evaluation of plutonium use in high-temperature gas-cooled reactors, 25:60097 (ORNL-TM-3525)
THOMPSON, A. R., Absorption-line study of galactic H at 21 cm, 25:58651
THOMPSON, F. T., Solid-state rod control system for pressurized water reactors, 25:60066
THOMPSON, G. D., S- and P-wave K^+p scattering below 600 MeV/c, 25:59489
THOMPSON, G. I., Intrinsic variations of interstellar extinction laws, 25:58489
THOMPSON, I. M. G., Energy response of some commercial beta/gamma and neutron survey instruments, 25:57781
  Intercomparison of the characteristics of beta/gamma and neutron survey instruments, 25:57782
THOMPSON, M. W., Channeling, 25:59165
  Low-angle scattering of energetic ions from an amorphous surface, 25:58689
  Sputtering, 25:58693
THOMSEN, J. M., Analysis of Jorum containment, 25:57607
THOMSON, D. M., Solar diurnal variation of cosmic rays at the 1954 solar minimum, 25:58824
THORINGTON, John M. Jr., Design and construction of a four-decade digital log ratemeter, 25:57893
THORNE, R. M., Locating the magnetospheric ring current, 25:58854
THORPE, M. R., Phase-integral correction for calculations of radio-wave absorption in the ionosphere, 25:58875
THOULESS, D. J., Excitations, 25:59204
THURMAN, Gary Boyd, Growth dynamics of osteosarcomas in Beagles, 25:57918
TIERNAN, T. O., Abundance of excited O^+ ions produced by electron impact on O_2, CO_2, N_2O, NO_2, and H_2O, 25:58763
TIKHONOV, A. N., Determination of photonuclear reaction cross sections, 25:59772
TIKHONOV, E. G., Measurement of fast-neutron spectra with threshold detectors, 25:57775
TIKHONOV, G. M., Radioactive isotopes in railway transportation, 25:57672
TILLSON, D. D., CCTL Mark II subassembly shipping procedure, 25:57612 (HEDL-TME-71-114)
TINSLEY, Beatrice M., Evolution of M31 disk population, 25:58491
TIP, A., Transport equations for dilute gases with internal degrees of freedom. II, 25:59224
TISHCHENKO, M. A., Use of a Tb complex in determination of rare earth elements, 25:57317
TITHERIDGE, J. E., Magneto-ionic mode coupling of hf radio waves, 25:58870
  Mode coupling of hf waves in the ionosphere, 25:58871
TKACHENKO, O. E., Structure of decomposed Co--Nb alloy, 25:58280
TOACSAN, M., Storage behavior of sintered uranium oxides, 25:58371
TOBENFELD, Emile Saul, Boltzmann transport equation for quasi-particles in liquid ^{3}He and for phonon gas, 25:59215
TODOROV, S., Use of chromosome analysis for biological dosimetry in connection with an accident involving ^{226}Ra, 25:58016
TOELGYESSY, Juraj, Continuous neutron activation analysis, 25:57388
TOEPFFER, Christian, Q-value dependence of multinucleon transfer reactions, 25:59845
TOERNQVIST, N. A., Crossing and isospin symmetric description of anti KN $\pi\pi$ anti Λ system using generalized Veneziano model, 25:59488
  Isospin invariance and πN backward scattering, 25:59287
TOET, D. Z., Cross sections and spin-density matrix elements for two-body reactions in 5 GeV/c π^+p two-pronged interactions, 25:59297
TOH, Kentaro, Electron microscopic study on acute thymic involution induced by polyoma virus infection, 25:58114
TOKONAMI, Masayasu, Crystallography of V/sub n/O/sub 2n-1/ (3 less than or equal to n less than or equal to 8), 25:58393
TOLIVER, Lee, Program FGCD (user's and programmer's manual), 25:60287 (SC-M-710408)
TOLLER, M., Two-particle correlations in high energy production experiments, 25:59436
TOLOK, V. T., Conference on plasma physics and problems of controlled thermonuclear synthesis, Kharkov, 5/68. I, 25:58957
TOLSTOUSOV, V. N., Potentiometric determination of microconcentrations of iodide ions, 25:57314
TOMASEK, M., Dosimetric checking of ^{90}Sr in biological chain, 25:57366
TOMASKOVA, Lenka, Installation of neutron-generator NA-2, 25:59676
TOMIK, B., Polarographic method of determining uranium in the presence of iron, 25:57321
TOMINAGA, Hiroshi, Computer analysis of gamma-ray spectra, 25:57810
TOMSIC, M., Thermal contact resistance by reflection of heat diffusion waves, 25:57644
TONEEV, V. D., Interaction of high-energy radiation with matter, 25:59508 (ORNL-tr-2514)
TOOSI, M. A., Prog. rpt. on research in experimental and theoretical nuclear physics, annual, 7/15/71, 25:59841 (ORO-4119-1)
TORCHINOVA, R. S., Magnetic properties of Sm--Gd alloys, 25:59176
TORIZUKA, Kanji, Positive scintiphotography of cancer of the liver with ^{67}Ga citrate, 25:58045
  Studies on liver function test with ^{131}I BSP monoiodide and scinticamera, 25:58042
TORIZUKA, Yoshiharu, Study of nuclei by electron scattering, 25:59736
TOROPCHINOV, A. N., Radioactive isotopes in railway transportation, 25:57672
TOROPOV, Yu. S., Making heating elements on the basis of zirconium dioxide for high-temperature furnaces, 25:58357
TORREITER, A., Rectifying process in surface barrier detectors, 25:57741
TOUZILLIER, Lucien, Secondary electron emission from germanium under electron bombardment, 25:58683 (FRNC-TH-49)
TOVAR Z., Enrique, ^{75}Se-selenomethionine in scintallography of thyroid and hepatic lesions, 25:58054
TOWNSEND, Harold Edward, Coolant recirculation system, 25:60067
TRAJKOVIC, M., Neutron dose determination with activation and biological detectors, 25:58019
TRAJMAR, S., Selection rule for Σ^+ in equilibrium Σ^- transitions in electron--molecule collisions, 25:58732
TRAUTVETTER, H. P., K/sup π/ = 1^+ rotational band in ^{18}F, 25:59715
TREFIL, J. S., Nuclear reactions initiated by recoil nuclei, 25:59814
  Predictions for elastic and inelastic nucleon--nucleus cross sections at high energies, 25:59519
TREHAN, S. K., Oscillations of a magnetic polytrope, 25:58507
TRET'YAKOV, V. I., Study of creep in niobium--molybdenum alloys, 25:58222
TRIEB, L., Recovery of resistivity of α irradiated Al

foils, 25:59158
TRILLING, G. H., π^+p elastic scattering at 3.6 GeV/c, 25:59292
TRIMBLE, G. D., Application of photoinduced reactions to nuclear materials safeguards problems. Project summary report, July 1, 1970--June 30, 1971, 25:57704 (GULF-RT-A-10826)
TRIOLO, L., Realization of chiral symmetry in meson states through SU(4) x O(3), 25:59551
TRIPATHI, B. M., Dependence of molecular dissociation equilibrium on magnetic field strength in sunspots, 25:58589
  Dissociation equilibrium of some diatomic molecules in delta Cephei, 25:58479
  Effect of scattered light on the facula-to-photosphere contrast, 25:58587
TRIPATHI, D. N., Formula for ionization cross section of neutral atoms by electron impact, 25:58738
TRIPATHY, Kishor C., Representations of O(3), 25:59536
TRIPATHY, Sarat Chandra, Effects of magnetic storms on electric power systems, 25:58887
TRITTON, K. P., Optical monitoring of radio sources. III, 25:58568
TROESCH, G., Dosimetric characteristics of a Teflon--carbon mixture for the construction of cavity chambers for measurement of absorbed dose in the air, 25:57861
TROFIMOV, A. S., Method for determining the coefficients of reactor transfer functions, 25:60229
TROFIMOV, M. G., Properties of ceramic coatings of phosphate ceramics, 25:58375
TROFIMOV, V. I., Radicals in γ-irradiated hydrates of cyclic ethers, 25:57465
  Radicals in γ-irradiated hydrates of three-membered cycles, 25:57476
TROSHICHEV, O. A., Unstable radiation zone: region where auroral and semitrapped particles are trapped, 25:58906
TROSHIN, V. S., Measurement of fast-neutron spectra with threshold detectors, 25:57775
TROYANKER, L. M., Express determination of yttrium in rare earth concentrates by the method of activation with fast neutrons, 25:57382
TRUBITSYN, V. P., Phase diagrams of hydrogen and helium, 25:58675
TRUKHANOV, K. A., Effect of secondary emission on potential of metallic body in radiation fields of the Earth, 25:59115
TRUSOV, V. F., Screening effects on internal conversion from outer atomic shells, 25:59787
TRUXOVA, G., Deoxycytidinuria in persons occupationally exposed to chronic irradiation, 25:58145
TSAI, Hui-tuh, Study of photo-nuclear reaction by means of residual nucleus method, 25:59815
TSAI, J. T., Statistical mechanics of an electron gas in a magnetic field, 25:59223
TSAI, Tsung-yuan, Application of modern control theory to spatially dependent nuclear reactors, 25:60213
TSANOS, N., g-meson, 25:59298
TSAREV, V. A., Reaction $\pi^-p \to$ etan and universality of complex trajectories, 25:59479
TSEITLIN, N. M., Radio intensity of Virgo A in 10 to 30-cm range, 25:58525
TSIRLIN, I. I., Induced reactions in radiochemistry. V, 25:57411
  Induced reactions in radiochemistry. VI, 25:57413
TSIVOGLOU, Ernest C., Nuclear power: risks and social concerns, 25:60001
TSOGLIN, Yu. I., Investigation of the calibration characteristics of a radiation thermodiverter in high-intensity fields of ionizing radiations, 25:57879
TSOGLIN, Yu. L., Possibility of variations in unit pulses of radiative heat, 25:57878
TSUBOTA, Hiroaki, (γ,α) reaction experiment, 25:59734
  Isospin effect in ^{31}P(γ,n) reaction, 25:59765
TSUCHIYA, Eiko, Electron microscopic study of radiation effects on cultured cells with different radiosensitivities, 25:58085
TSUEI, C. C., Occurrence of superconductivity in simple cubic (Au/sub 1-x/Pd/sub x/)Te$_2$ alloys, 25:58928 (CALT-822-37)
TSUJI, H., Rapid determination of boron in glass by prompt γ-ray measurement, 25:57369 (RFP-Trans-83)
TSUSHIMA, Toshio, Radioimmunoassay for canine growth hormone, 25:57909
TSUYA, Asahi, Effects of irradiation on the central nervous system, 25:58143
TSUYA, Kazuo, Effects of grain size and carbon content on the ductility of recrystallized molybdenum wire, 25:58269
TSVETKOV, Yu. B., Kinetics of the reduction of tungsten and molybdenum trioxides by hydrogen, 25:58189
TSYGANOV, V. A., Effect of hygromycin B and streptomycin on Actinomyces hygroscopicus variability induced by x-irradiation, 25:57964
TSYKANOV, V. A., Criteria for comparison of research reactors, 25:60167
TUAN, S. F., Implications of a charge asymmetry in ω^0 Dalitz plot, 25:59468
TUCKER, W., Experimental work in the Brookhaven Chemonuclear In-Pile Research Loop, 25:57610 (BNL-50293)
TUPLIN, T. A., Preparation of stable and active nuclide targets, 25:59635 (CONF-711002-, pp 91-100)
TUPPER, B. O. J., Generalized field equations in general relativity, 25:59591
TURCO, Richard Peter, Investigation of the ionospheric D region at sunrise, 25:58899
TURI, L., Program for the determination of neutron spectra from activation data, 25:57725 (KFKI-71-22)
TURKIEWICZ, J., Reactions (n,α) on heavy nuclei induced by 14.2-MeV neutrons, 25:59802
TURNBOW, James W., Preliminary impact speed and angle criteria for design of a nuclear airplane fission product containment vessel, 25:60192 (N-71-25411)
TUROS, A., Reactions ^{9}Be(d,α_0)^{7}Li (ground state) and ^{9}Be(d,α_1)^{7}Li* (470 keV), 25:59721
TURSKA, Ryszarda, Pathologic changes in ultrastructure of hepatocytes in the axolotl, 25:58112
TUTOV, V. I., Anomalous behavior of the superconducting transition temperature of lead with a distorted crystal lattice, 25:58933
TUTTER, M., Simple low-loss coupling method for RF heating of plasma ions by electrostatic ion-cyclotron waves, 25:58962 (IPP-IV-25)
TYKVA, R., Planar distribution of low-energy β-nuclides using computer controlled equipment with a semiconductor detector, and comparisons with other methods, 25:57769
TYUFYAKOV, N. D., Neutron beams from isotope neutron sources, 25:59690

U

UBOVIC, Z., Neutron dose determination with activation and biological detectors, 25:58019
UCHAIKIN, V. V., Defect detection in gamma-scintillation nondestructive testing, 25:57701
UCHIDA, Kazuyoshi, Earthquake response analysis of nuclear power plant, 25:57598
UCHIDA, Masaaki, Uranium dioxide fuel pin elongation behavior under irradiation, 25:58414
UCHIDA, Tomiyoshi, Chiral invarient Lagrangian with massive gauge fields, 25:59449
UEDA, Y., $\Delta I \to 1$ mass differences and eta $\to 3\pi$ decay, 25:59380
UENO, Kaoru, Precipitation of some actinide element complex ions by using hexammine Co(III) cation. III, 25:57403
UENO, Sueo, Bellman's new approach to solution of Fredholm integral equations, 25:59110
UETOMI, Isamu, Performance of clinical linear accelerator, 25:59661
UEYAMA, Hiroshi, Phenomenological theory on critical phenomena in liquid He. II, 25:58912
UHRHANE, Francis Joseph, Elastic electron scattering from oriented ^{165}Ho nuclei, 25:59796
ULMSCHNEIDER, Peter, Propagation of a spectrum of acoustic waves in the solar atmosphere, 25:58579
ULSHMID, I., Plasma density measurement by means of an open resonator, 25:58977 (AEC-tr-7271)
UMANSKII, S. Ya., Some cooling processes for the interstellar medium, 25:58623
UMEDA, Keiji, Carotenoids accumulation and changes of carotenoid pattern of Japanese persimmon by cathode ray irradiation, 25:57926
UMEGAKI, Yoichiro, Real time dose distribution display by digital computer, 25:58078
UMLAUF, E., Measurements of NMR on oriented ^{192}Ir and /sup 191m/Ir in Ni and Fe host lattices, 25:59807
UNDERHILL, A. B., Aspects of non-LTE physics of He atom in hot stars, 25:58472
UPADKHAYA, G. Sh., Electro-erosion resistance of refractory carbides within corresponding ranges of homogeneity, 25:58356
URASHIMA, Shin-o, Two-dimensional magnetohydrodynamic channel flow in a nonuniform magnetic field, 25:58843
URBAN, K., Growth of interstitial and vacancy agglomerates in nickel during electron irradiation, 25:58328
URNOV, A. M., Orbital quantum number distribution of highly excited atoms produced in collisions between heavy particles, 25:58734
USHAKOV, S. N., Measurement of fast-neutron spectra with threshold detectors, 25:57775
USHAKOV, Yu. V., Temperature effect in 20 to 250°C range for certain, strictly regular, heterogeneous, U--H$_2$O critical assemblies, 25:60161
USMANOVA, M. M., Determination of impurities in pyrographite by method of delayed coincidences of β and γ radiation, 25:57389
USOV, V. V., Possibility of a pulsed mass outflow from a rotating magnetic star, 25:58431
USYNIN, G. B., Stabilization of the heat-output field in fast reactors by control elements, 25:60045
UY, Z. E. S., Neutral kaon decays into muon pairs and violation of CP invariance, 25:59544
UZES, C. A., Asymmetry in the asymptotic identification, 25:59545

V

VAERMAN, J. P., Serum concentrations of immunoglobulin in

XUM

pigs after exposure to γ ray, 25:58104
VAGER, Z., Time reversal invariant formulation of average compound cross sections, 25:59873
VAIDYANATHAN, K. V., Infrared absorption studies in neutron- and electron-irradiated GaAs, 25:59155
VAINBERG, M. Sh., Comparison of calculated and experimental dose fields of a proton beam, 25:58023
VAKLEV, J., Classification and mass formulas for mesons in ladder U(6,6) symmetry, 25:59546
VAKSBERG, G. M., Increased resistance of animals to renal poisons, 25:58099
VALENCIA, Juan I., Radiation induced DNA synthesis in the polytene chromosomes, 25:57951 (COO-1747-6)
VALENSTEIN, Edward, Schilder's disease. Positive brain scan, 25:58048
VALIEVA, M. G., Determination of impurities in pyrographite by method of delayed coincidences of β and γ radiation, 25:57389
VAN AGT, Steven, Faint supernova in an anonymous southern galaxy, 25:58455
VAN AUDENHOVE, J., High-temperature neutron dosimeters, 25:57723 (CONF-711002-, pp 82-5)
  Sample preparation by metallurgical methods, 25:58179 (CONF-711002-, pp 47-58)
VAN DAM, H., Massive and mass-less Yang--Mills and gravitational fields, 25:59601
  Mechanism for CP nonconservation, 25:59539
VAN DAMME, Jacques, Storage of radioactive substances, 25:57719
VAN DE BRAAK, H. P., Complete sets of diagonal operators in quantum-statistical mechanics, 25:59222
VANDENBORRE, H., Recovery of rhenium following low-temperature alpha-particle irradiation, 25:59142
VAN DER EIJK, W., Sampling and dilution problems in radioactivity measurements, 25:57498 (CONF-711002-, pp 283-92)
VAN DER KRUIT, P. C., Observations of core sources in Seyfert and normal galaxies, 25:58642
VAN DER WIEL, M. J., Multiple ionization of Ar by 10-keV electrons, 25:58754
VAN DER WOUDE, A., Elastic scattering of 40-MeV protons from ^{48}Ti, /sup nat/Cr, and ^{64}Zn: tabulated differential cross sections, 25:59739 (ORNL-TM-3591)
VAN DONGEN, R., Gross radioactivity in airborne dust, 25:57575 (RA-42)
VAN HOVEN, G., Longitude distribution of solar flares, 25:58570 (N-71-14166)
VANINBROUKX, R., Sampling and dilution problems in radioactivity measurements, 25:57498 (CONF-711002-, pp 283-92)
VAN VLECK, J. H., Group theory for permutation degeneracy in four electrons and the Pauli exclusion principle, 25:59235
VAN VLIET, K. M., Markov approach to density fluctuations due to transport and scattering. I, 25:59236
  Markov approach to density fluctuations due to transport and scattering. II, 25:59237
VARDYA, M. S., Model of interstellar grains with surface roughness, 25:58637
VARGO, G. N., Development of a mixer-settler for liquid metal-salt systems, 25:57508 (ANL-7810)
VARKOVITSKAYA, A. Ya., Complex investigation of extensive air-shower core with energy greater than or equal to 10^{15} eV, 25:59249
VARSHALOVICH, D. A., Spin state of atoms and molecules in a cosmic medium, 25:58665
VARTAPETYAN, G. A., Nuclear photofission cross sections for photon energies up to 5 GeV, 25:59794
VASCULESCU, Tr., Effect of low x-ray doses on central nervous system, 25:58098
VASILEV, G., Use of chromosome analysis for biological dosimetry in connection with an accident involving ^{226}Ra, 25:58016
VASIL'EV, S. S., Neutron activation analysis of enriched isotopes of Eu, In, Ir, and Lu, 25:57391
  Use of (p,γ) reaction to determine light-element content in thin surface layers, 25:57396
VASIL'EV, V. P., Study of the composition of oxide coatings using radioisotopes, 25:57660
VASIL'EVA, E. V., Study of creep in niobium--molybdenum alloys, 25:58222
VAS'KO, A. T., Microhardness and internal stresses of electrolytic nickel--tungsten alloys, 25:58236
VAS'KOV, V. V., Nonlinear theory of plasma motion in a high-frequency electromagnetic field, 25:59037
VASSEUR, Claude, Development of ^{242}Cm--Be and ^{238}Pu--Be neutron sources, 25:59669 (CEA-R-4172)
VASSEUR, J., Pulsed gamma emission above 50 MeV from NP 0532, 25:58542
VAU, Guenter, New power supply equipment for 28-GeV CERN proton Synchrotron, 25:59662
  New power supply system for the main ring magnets of 28-GeV CERN Proton Synchrotron, 25:59663
VAUGHAN, Burton E., Ecological and environmental problems in the application of biomathematics, 25:60262 (BNWL-SA-3977(Rev.))
VAUGHAN, J. M., Scattering of light from liquid helium, 25:58916
VAULINSKII, E. S., Superconducting alloys of Nb--Al--Ge system, 25:58948
VAVILOV, V. S., Radiation effects in CdTe, 25:59161
VAVILOVA, V. V., Oxidation of niobium containing oxygen, 25:58172
VAVREJN, Bohuslav, Process of manufacturing radioactive substances derived from difluorescenylmercury and labelled with radioactive iodine isotopes, 25:58047
VDOVENKO, V. M., Reduction of uranyl ion by Ti(III) in nonaqueous media, 25:57415
VEDRENNE, G., Extraterrestrial γ-ray contribution between 0.7 and 4.5 MeV, 25:58832
VEEH, H. Herbert, Anomalous ^{234}U/^{238}U on East Pacific Rise, 25:57585
VEHMEYER, H., Total effective cross sections for scattering of He, HD, and D_2 by several molecules, 25:58782
  Total effective scattering cross sections of HD-inert gas systems in thermal energy region, 25:58781
VELECKIS, E., Prog. rpt. on physical chemistry of liquid metals and molten salts, semiannual, 1--6/71, 25:58387 (ANL-7823)
VELJKOVIC, D., Biological dosimetry methods, 25:58018
VELKOBORSKY, J., Properties of zirconium alloys from the operation standpoint, 25:58217 (ZJE-107)
VELTMAN, M., Massive and mass-less Yang--Mills and gravitational fields, 25:59601
VELYUS, L. M., Neutron activation analysis of enriched isotopes of Eu, In, Ir, and Lu, 25:57391
VENEZIANO, G., Sum rules for inclusive cross sections, 25:59331
VENKATESWARLU, K. S., Isotope exchange and thermal annealing of recoil damage in trisoxinatocobalt(III), 25:57493
  Thermal annealing and solid state isotope exchange of ^{51}Cr in K trisoxalato chromate(III) trihydrate, 25:57490
VENKOV, S. N., System for automated one-element activation analysis, 25:57390
VERAGUTH, P., Usefulness and damages of ionizing radiations, 25:58030
VERBEEK, P. W., Complete sets of diagonal operators in quantum-statistical mechanics, 25:59222
VERBER, F., Development of an in-core permanent-magnet probe-type sodium flowsensor for operation in the Fast Flux Test Facility (FFTF), 25:60183
VERBINSKI, V. V., Prog. rpt. on fast reactor spectrum measurements, 5--7/71, 25:60156 (GULF-RT-A-10800)
VERDINGH, V., Preparation of layers by electrospraying and electrophoresis, 25:58183 (CONF-711002-, pp 160-5)
  Preparation of powder samples, 25:58181 (CONF-711002-, pp 77-81)
VERENKOVA, E. M., Properties of ceramic coatings of phosphate ceramics, 25:58375
VERHEIJ, W. S. D., Induction of mutations in bacteriophage by ionizing radiation, 25:57971
VERHEIJKE, M. L., Full-energy peak efficiency calibration of a well-type Ge(Li) gamma-ray detector, 25:57740
VERHEYEN, F., Assay of samples for nuclear measurements by physical methods, 25:59640 (CONF-711002-, pp 272-82)
VERMEULEN, Theodore, Jet-mixed liquid--liquid extraction column, 25:57623
VERNHES, C., Exposure of human beings to natural and artificial sources of ionizing radiations, 25:57994
VERPLANKE, J. C., Full-energy peak efficiency calibration of a well-type Ge(Li) gamma-ray detector, 25:57740
VERSTELLE, J. C., Complete sets of diagonal operators in quantum-statistical mechanics, 25:59222
VESELY, W. E., Reliability and fault tree applications at the NRTS, 25:60187
VETLITSKII, I. A., π^-p interactions at 3.25 GeV/c, 25:59314
VICH, Z., Deoxycytidinuria in persons occupationally exposed to chronic irradiation, 25:58145
VIDAL, R., Plutonium production in NPD: comparison between experiment and calculation, 25:60093 (AECL-3995)
VIGDORCHUK, L. I., Temperature dependences of Debye--Waller factors of Zr, Nb, and Mo, 25:59179
VIGOUREUX, J. M., Strong correlation between Cherenkov effect and certain properties of the photon-tachyons of disappearing Fresnel wave, 25:59573
VIITASALO, M., Nuclear levels and transitions in odd Cu isotopes. II, 25:59764
VIKTORA, L., Spleen of irradiated mice after transplantation of bone marrow, 25:58117
VIKTOROVA, Yu. N., Radiation effects on glass and ceramics, 25:59147
VILA, P., Upward-moving irregularities in the subequatorial ionosphere, 25:58877
VILKOVYSKII, G. A., Quantization of particles in the external gravitational field, 25:59599
VILLANI, A., Some exact inequalities involving S and P waves and their derivatives for πK scattering, 25:59452
VINEN, W. F., Scattering of light from liquid helium, 25:58916
VINH MAU, N., Optical potential for nucleon scattering on ^{40}Ca, 25:59744
VINOGRADOV, A. V., Orbital quantum number distribution of highly excited atoms produced in collisions between heavy particles, 25:58734
VINOGRADOV, N. I., Microwave absorption by a plasma at the upper hybrid frequency, 25:59091
VINOGRADOV, V. M., Three-dimensional covariant formulation of the three-body problem in quantum field theory, 25:59577

XUM

VIRASORO, M. A., Functional approach to dual quark models, 25:59435
VISWANATHAN, R., Thermodynamics of titanium alloys. II. The Ti--Mo system, 25:58265
VITORSKII, Ya. M., Effect of the deformation temperature on the structure and mechanical properties of low-alloyed molybdenum, 25:58231
VITOVSKII, N. A., Donor--vacancy type complexes in germanium, 25:59133
VITTER, G., Electric conductivity of solid solutions of $(ThO_2)_{0.75}$--$(CeO_2)_{0.25}$ at high temperature, 25:58368
VLADIMIROV, V. G., Change in the level of redox potential in muscles of different animal species as a function of the dose of cystamine introduced, 25:58031
VLADIMIRSKII, V. V., Investigation of reaction $\pi^-p + pX^-$ at momentum of 3.25 GeV/c with high momentum transfer, 25:59312
VLAJIC, Milorad, Spatial temperature field of a concrete vessel, 25:60080
VLASOV, P. V., Investigation of erosion of high-pressure fittings by use of radioisotopes, 25:57662
VODOPYANOV, L. K., Radiation effects in CdTe, 25:59161
VOEGELI, E., Angiography, scintillation scanning, and ultrasound tomography of liver, 25:58044
VOGEL, Charles E., Induction plasma nozzle tests, 25:57640 (N-71-22551)
VOGEL, P. Christian, Relative tritium--deuterium isotope effects in the absence of large tunneling factors, 25:57430
VOGEL, R. C., Chemical Engineering Division fuel cycle technology quarterly report, January--March 1971, 25:57507 (ANL-7799)
  Chemical Engineering Division. Cross sections and burnup semiannual report, January--June 1971, 25:60035 (ANL-7824)
  Prog. rpt. on physical chemistry of liquid metals and molten salts, semiannual, 1--6/71, 25:58387 (ANL-7823)
VOGT, R. H., Activation analysis of sodium and potassium in solid propellants, 25:57384
VOICU, V., Mechanisms involved in the pharmacodynamic sensitivity changes in irradiated organisms, 25:58142
VOITKOVSKA, I., Angular distribution of the low energy neutrons from the nuclear μ-capture in sulfur and calcium, 25:59738 (JINR-P1-6029)
VOJTECH, D., Radionecrosis of the skin, 25:58038
VOL'BEK, A. I., Magnetohydrodynamic induction machines with liquid-metal working fluid, 25:58840
VOLGIN, V. I., VVR reactor semiautomatic activation analysis system, 25:60168
VOLKOV, A. B., Explanation for the 0^+ excited pairing state in actinide nuclei, 25:59809
VOLKOV, N. N., Constructional features of nuclear-powered vessels, 25:60204
VOLKOVA, L. V., Analysis of neutrino experiments in cosmic rays, 25:59417
VOLODIN, S. N., Dosimetric characteristics of silicon detectors for gamma radiation, 25:57850
  Spectrometric characteristics of germanium detectors with radiation defects, 25:57822
VOLYNETS, M. P., Behavior of various valence forms of Pu in acid--TBP system, 25:57357
VON HEYDEN, G., Recovery of rhenium following low-temperature alpha-particle irradiation, 25:59142
VORBURGER, Chr, Fluid and electrolyte spaces in chronic renal insufficiency, 25:57924
VOROB'EV, A. M., Removal of ^{60}Co from skin, 25:57982
VOROB'EV, E. I., Radiation safety of crew of Soyuz-9, 25:58006
VOROBTSOVA, I. E., Competitive capacity of Drosophila individuals heterozygous for x-ray induced mutations, 25:57966
VORONIN, A. I., Some cooling processes for the interstellar medium, 25:58623
VORONIN, Yu. V., Mechanical properties of molybdenum-base alloys, 25:58248
VORONINA, L. M., Angular and momentum distributions of μ^+ mesons in reactions of direct production of leptonic pairs by neutrino beam in electromagnetic field of nuclei and nucleons, 25:59415
VORONTSOV-VELYAMINOV, B. A., Quasars: preclusters of galaxies, 25:58523 (CSIRO-Trans-10650)
VOROZHBITSKAYA, K. F., Use of ion-exchange chromatography in determination of vanadium in ferrovanadium and iron ore, 25:57335
VORPAHL, Joan, Magnetic fields, bremsstrahlung, and synchrotron emission in flare of Oct 24, 1969, 25:58609
VOSLAMBER, D., Electron correlations in unified line shapes, 25:59026 (CEA-CONF-1834)
VOTRUBA, I., Radiation biochemistry in plants. I, 25:57941
VOURVOPOULOS, G., Distribution of T/sub </ states in ^{89}Y, 25:59750
VOZILKIN, V. A., Structure of superconducting alloy Ti--22 at. percent Nb, 25:58942
VREELAND, T. Jr., Basal dislocation interactions with a forest of non basal dislocations in zinc, 25:60267 (CALT-767-P-3-18)
  Dislocation mobility in copper and zinc at 44°K, 25:60265 (CALT-767-P-3-16)
  Experimental determination of the line energy of a basal screw dislocation in zinc, 25:60266 (CALT-767-P-3-17)
  Measurement of dislocation damping forces at high dislocation velocity, 25:60264 (CALT-767-P-3-15)
  Observation of slip bands in molybdenum single crystals by x-ray diffraction, 25:58271 (CALT-767-P-3-19)
VRIENS, L., Scattering of polarized electrons from magnetic materials, 25:58687
VUCETICH, H., Regularization of three-vertex Feynman diagrams produced by three-point supergraphs, 25:59568
VUGTS, H. F., Diffusion coefficients of isotopic methane mixtures and of methane--rare gas mixtures, 25:57434
VUKANOVIC, V., Investigations in physical chemistry of the arc plasma, 25:58998
VYLEZHNIN, I. A., Automatic ultrasonic installation for decontamination of footwear on human legs, 25:57629

W

WAAST, B., Charged particle detectors made by implantation, 25:57749
WADATI, M., Statistical mechanics of an electron gas in a magnetic field, 25:59223
WADZINSKI, H. T., Relativistic atomic Hamiltonian, 25:58799
WAGEMANN, R., Ternary system silver--indium--aluminum, 25:58287
WAGNER, C. E., High-Mach-number turbulent magnetosonic shocks, 25:59044
WAGNER, H. N. Jr., Study of the reticuloendothelial system in hematological diseases, 25:58053
WAGNER, R., Stellar groups Ba 8, Ba 9, and Be 68, 25:58439
WAGNER, S., rho-exchange contribution to $\gamma n + \text{rho}^-p$, 25:59385
WAHLBECK, Phillip G., Prog. rpt. on high temperature chemistry: fundamentals of effusion and thermodynamics of materials, final, 6/61--8/71, 25:57435 (COO-1029-39)
WAIBEL, E., Geometric factors for angular correlation measurements with gamma radiation, 25:57733
WAKABAYASHI, Jiro, Analysis of space-dependent dynamic properties of power reactors, 25:60240
WAKAMATSU, Seiji, Stability study of a PWR nuclear power station connected to an electric power system, 25:60105
WAKATSUKI, Tetsuo, Lifetime measurements of excited states in ^{19}Ne and ^{23}Mg, 25:59719
WALD, R. M., Black holes as agents of magnetic fields, 25:58498
WALDMAN, J., Nature of the impurity phase in a age-hardenable Mg-10.8 wt. percent Y alloy, 25:58293
WALDSCHMIDT, L. A., Technique for hot cell autoradiography, 25:57693
WALKER, J. B., DFR primary circuit failure, 25:60078
WALKER, Mary J., Tumors of skin. XII, 25:58037
WALKER, W. D., Analysis of N*(1500) and N*(1700) baryon resonances produced via diffraction dissociation, 25:59307
  Observation of natural-parity exchange in rho^0 production, 25:59286
WALLACE, J. R., Energy control and monitoring system for a tandem Van de Graaff, 25:59653
WALLANDER, E., Thermal neutron capture investigation of the ^{172}Yb and ^{174}Yb level structures, 25:59825
WALLIS, Max, Shock-free deceleration of the solar wind, 25:58615
WALSH, R. L., Energy dependence of anti ν/sub p/ for ^{233}U, ^{235}U, and ^{239}Pu, 25:59810
WALSH, T. F., Photoproduction of e^+e^-, rho--ω mixing and vector dominance, 25:59364
WALTER, J., Upward-moving irregularities in the subequatorial ionosphere, 25:58877
WALTERS, G. P., Effect of cold work on swelling of Type 316 steel irradiated with 20 MeV C ions at 525°C, 25:58324
  Temperature dependence of void swelling in 18/8/Ti steel, 25:58323
WALTNER, A. W., K- and L-shell electron shake-off in the beta decay of ^{204}Tl, 25:59792
WALTON, J. T., Pulsed feedback techniques for semiconductor detector radiation spectrometers, 25:57812
WALTZ, R. E., One-loop amplitudes in model of Neveu and Schwarz, 25:59433
WANG, C. G., Limiting mass of a neutron star, 25:58564
WANG, Richard Yuan-chang, Nuclear spin relaxation studies in solid and liquid deuterium, 25:59202
WANTLAND, J. L., ORRIBLE: a computer program for flow and temperature distribution in LMFBR fuel rod bundles, 25:60062 (ORNL-TM-3516)
WARD, A. L., Mechanical properties of fast reactor irradiated austenitic stainless steel weldment materials, 25:58296 (HEDL-SA-196)
WARD, Robert George, Power plants, 25:60141
WARD, W. T., Utility of ice cubes as an absorbent for gaseous fission products, 25:60124
WARD-SMITH, D. F., Further structure in giant resonance region of ^{12}C, 25:59732
WAREDA, Eugeniusz, Application of the tracer method in investigations of evaporation phenomena in power boilers, 25:57674
WARHAM, A. G. P., Numerical solution of the unsteady radiative-transfer equation, 25:59114
WARNER, R. E., Charge-exchange and/or knockout spectator

XUM

poles in reaction D(^{3}He,tp)p, 25:59694
  Coincidence study of reaction ^{2}H(d,dp)n, 25:59699
WARREN, Holland D., Radiation detector, 25:57755
WASE, Keizo, Torus device for thermonuclear fusion equipment: JFT-1, 25:59079
WASHINGTON, W. D., Comparison of paints by neutron activation analysis. II. Colored paints, 25:57373
  Use of neutron activation analysis for the characterization of paper, 25:57374
WASILEWSKI, R. J., Voids in intermetallic compound NiAl, 25:58318
WATANABE, Katsushi, Effects of pH on /sup 113m/In distribution, 25:58043
WATANABE, Setsuko, Pitch-angle distribution of fast electrons, 25:58904
WATANABE, Tsunetoshi, Compton scattering at high energies, 25:59340
WATERS, S. L., ^{52}Fe: improving its recovery from cyclotron targets, 25:57486
WATSON, B. A., Elastic scattering of 5- to 10-MeV protons from aligned ^{165}Ho, 25:59788
WATT, L. A. K., Infrared absorption studies in neutron- and electron-irradiated GaAs, 25:59155
WAYLAND, J. R., Transverse-momentum distribution of produced secondaries from statistical thermodynamic models of strong interactions at high energies, 25:59427
WAYMARK, R. D. B., Use of an on-line digital computer for enhancement and integration of nuclear resonance spectra, 25:57887
WEARE, John H., Reaction matrix method for computing probabilities of vibration--translation energy transfer, 25:58762
WEBB, G. A. M., New high-sensitivity thermoluminescent dosimeter for short-term personnel dosimetry, 25:57847
WEBER, A. H., Behavior of low-density plasma in presence of cylindrical Langmuir probes, 25:58999
WEBER, Walter J. Jr., Interaction of silicic acid with Fe(III) and uranyl ions in dilute aqueous solution, 25:57406
WEBSTER, B. L., Optical identification of Cygnus X-1, 25:58554
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WEBSTER, William J. Jr., Aperture-synthesis observations of M17 and W49A at 2.695 GHz, 25:58557
WEECH, Marx Elson, Irradiated nuclear fuel recovery process, 25:57534
WEEDMAN, Daniel W., Very blue stellar objects appearing near galaxies, 25:58539
WEGNER, G., Tumors of albino rats of various ages after single total-body roentgen irradiation, 25:58097 (ORNL-tr-2521)
WEIGL, F., Plasma diagnostics utilising optical interferometry and holographic techniques, 25:59001
WEINBERG, Alvin M., Prudence and Technology: a technologist's response to predictions of catastrophe, 25:59898
WEINER, Richard M., Antibaryon--baryon scattering problem, 25:59467
WEIR, C. G., Chapelcross melt-out and recovery operations, 25:59923
WEISS, Herbert V., Determination of selenium in glacial ice by radioactivation, 25:57394
WEISSMANN, S., Application of the x-ray synergy method to analysis of room temperature compression of beryllium crystals, 25:58263
WELIACHEW, L., Hydrogen line and continuum study of Maffei 2 by radio interferometry, 25:58632
WELTER, H., Validity of quasi-linear approximation for turbulent plasmas, 25:59027 (IPP-6/94)
WENZEL, W., Change-over to new forms of energy in the iron and steel industry, 25:60200
WERBROUCK, A. E., Analysis of A_1 and A_2 regions in reaction $\pi^+p \to \pi^+\pi^+\pi^-p$ at 5 GeV/c, 25:59475
WERNER, A., Direct method of measuring total radiation dose to the brain using the Fricke dosimeter, 25:58012
WERTER, Witold, Utilization of W in Polish industry, 25:58164
WESLEY, John C., High-field electron g -2 measurement, 25:59560
WEST, D., Neutron yield from protons and deuterons in lead, 25:59820
WEST, J. K., Analysis of contaminations in biological samples by heavy ion scattering, 25:57359
WEST, J. M., Study of the electrochemistry and morphology of electro-deposited nickel--molybdenum alloys, 25:58256
WEST, Robert G., Selected, annotated bibliography of the civil, industrial, and scientific uses for nuclear explosives, 25:57603 (TID-3522(Rev.9))
WESTERLUND, B. E., Catalog of C stars in southern Milky Way, 25:58500
WESTHAUS, Paul, Properties of correlation functions in Sinanoglu many-electron theory, 25:58806
WESTMACOTT, K. H., Formation and behaviour of quenched-in voids in close packed metals, 25:58317
WHALEN, Stephanie A., Pulmonary cell responses to metallic oxides, 25:57923
WHAN, R. E., Preferential etching of ion-bombarded GaAs, 25:59141
WHEATLEY, B. M., Health physics control, 25:59926
WHEELER, J. C., Ultradense matter, 25:58432
WHIPP, A. T., Rho--omega interference and the phase of the rho-propagator, 25:59348
WHITE, Michael Thomas, Effects of ultraviolet irradiation on DNA synthesis in Chlamydomonas reinhardi, 25:57925
WHITE, R. E., Vector and tensor analysing powers of the D(d,p)T and D(d,n)^{3}He reactions at 10.0 and 11.5 MeV, 25:59700
WHITE, R. W., New high-temperature phase of protactinium metal, 25:58291
WHITLOW, G. A., Metallography of the 300 series stainless steels exposed to high temperature sodium, 25:58174
WHITMAN, G. D., Fracture investigations and status of the Heavy-Section Steel Technology Program, 25:60075
WHITNEY, C. A., Line formation in pulsating variable stars, 25:58543
WHITNEY, E. D., Prog. rpt. on quantitative determination of the structure-property relationships in nuclear fuel element materials, 3/15/71--6/15/71, 25:58389 (SRO-552-8)
WHITSON, G. L., Actinomycin D in radioprotection and radiosensitization in Tetrahymena, 25:58091
WHITTEN, R. C., Ionosphere of Mars below 80 km altitude. II, 25:58676
WHITTON, J. T., Biological aspects of skin irradiation. III, 25:58000 (RD/B/R-1934)
WIDNER, M. M., Containment in Tokamak and bumpy torus, 25:58961 (CONF-711016-1)
WIEBES, G., Multiple ionization of Ar by 10-keV electrons, 25:58754
WIECEK, Edward, Method for determining the mass of dust deposited on membrane filters by measurements of the absorption of beta rays, 25:57870
WIECZOREK, E., Transformation properties of states at infinite momentum II, 25:59321 (JINR-E2-5993)
WIENECKE, R., Arc discharges in strong magnetic fields, 25:59005
WIFFEN, F. W., Effect of alloying and purity on the formation and ordering of voids in BCC metals, 25:58300 (ORNL-TM-3496)
WIGGINS, P., Comparison of stainless steel and Zircaloy-2 as encapsulation materials for ^{252}Cf, 25:58242
WIKSTROEM, K., Evidence for high-spin core-excited states in ^{210}Po, 25:59817
WILBUR, Robert E., On-line, digital data handling and optimal control investigations at the Missouri University Research Reactor, 25:60185
WILHELMI, Z., Compound nucleus formation in reaction ^{3}H(d,n)^{4}He, 25:59706
  Measurement of γ-ray spectra accompanying radiative capture of nucleons, 25:59801
  Reactions ^{9}Be(d,α_0)^{7}Li (ground state) and ^{9}Be(d,α_1)^{7}Li* (470 keV), 25:59721
WILKINS, A. L., Liquidus determinations in pseudo-ternary sub-system CaO.Nb$_2$O$_5$--CaO.TiO$_2$--SiO$_2$, 25:58390
WILKINS, Mark L., Calculation of surface and ground waves from above-ground and underground explosions, 25:57594 (UCRL-73369)
WILKINSON, D. H., ft asymmetry in mirror Gamow--Teller β decay, 25:59852
WILLIAMS, Brian R., Scattering of He atoms by phonons in (001) surface of LiF at 150°K, 25:58694
WILLIAMS, H. T., Effect of baryon resonance admixtures on elastic electron deuteron scattering, 25:59367
WILLIAMS, I. P., Planetary formation from charged bodies, 25:58591
WILLIAMS, J., Chemical Engineering Division. Cross sections and burnup semiannual report, January--June 1971, 25:60035 (ANL-7824)
WILLIAMS, K. R., Theoretical model for void formation in the high voltage microscope, 25:58316
WILLIAMS, M. M. R., Propagation of sound waves and neutron waves in bounded plane geometry, 25:59679
WILLIAMS, R., Surface-state lifetimes and current flow in liquid helium, 25:58911
WILLIAMS, T. M., Temperature dependence of void swelling in Type 316 austenitic stainless steel irradiated with 20 MeV C^{++} ions, 25:58321
WILLIAMS, W., Selection rule for Σ^+ in equilibrium Σ^- transitions in electron--molecule collisions, 25:58732
WILLIG, W. R., Experimental investigations of exotic semiconductors for nuclear particle detection, 25:57807
WILLIS, D. E., Investigation into the potential seismological effects of the Cannikin Event, 25:57590 (COO-2138-4)
WILLIS, J. R., Interaction between a void and a dislocation loop, 25:58315
WILSON, B. G., Rigidity dependence of Forbush decreases and 11-year variation in cosmic-ray intensity, 25:58823
WILSON, M., Evaluation of effective operators for configuration interaction, 25:58798
WILSON, S. S., Isospin invariance in reaction np $\to \pi^0$d, 25:59268
WIMMEL, H. K., Tachyon mechanics and classical tunnel effect, 25:59556 (IPP-6/95)
WING, Ralph O., Investigation of fluorine interactions with common glovebox construction materials, 25:57619 (RFP-1739)
WINK, Joern E., Aperture-synthesis observations of M17 and

W49A at 2.695 GHz, 25:58557
WINKLER, John H. Jr., Radioactivity and electrical logging tool combination, 25:57571
WINNEWISSER, Gisbert, Rotational constants for HCN and DCN, 25:57423
WINNINGHAM, John David, Penetration of magnetosheath plasma to low altitudes through the dayside magnetospheric cusps, 25:58882
WINSLOW, J. W., Radiation hardness of a new magnetic thin-film recording system, 25:57908
WINTER, J., High count rate two parameter system with a Ge(Li)-detector, 25:57806
WINTERS, R. W., Determination of trace elements in soils and clay minerals by resonance neutron activation analysis, 25:57375
WINTON, M. L., Computer codes for analyzing nuclear accidents, 25:60127
WIRTHS, G., State of fuel cycle industry in Federal Republic of Germany, 25:57666
WIRTZ, Heribert, Significance and use of intermediate layers during welding and metal spraying, 25:58204
WITHBROE, George L., Electron densities derived from line intensity ratios: beryllium isoelectronic sequence, 25:58599
WITHERS, H. R., Regeneration of intestinal mucosa after irradiation, 25:58111
WITKOVER, Richard L., Valve and pulse-width-modulated data link using infrared light to control and monitor power supply for modulator for high-energy linear accelerator, 25:59660
WITT, F. J., Fracture investigations and status of the Heavy-Section Steel Technology Program, 25:60075
WITTE, L. C., Transient film and transition boiling from a sphere, 25:57642
WITTIG, J., Low-temperature electrical resistivity of YCe under pressure, 25:59195
WITTKOWER, A. B., Charge-changing cross sections for heavy ions in complex molecules, 25:58768
WITTMAACK, K., Depth distribution of characteristic x-ray production in Cu by 12- to 30-keV electrons, 25:58685
WOELFLI, W., Photofission of ^{232}Th near threshold, 25:59786
WOJTECH, B., Thorex two-stage process for reprocessing thorium reactor fuel with high burnup, 25:57541
WOLBER, G., Operating experience and results obtained with TRIGA research reactor, 25:60173
WOLF, F., Scintigraphic diagnosis by means of short-lived radionuclides, 25:58060
WOLF, H. J., Gross radioactivity in airborne dust, 25:57575 (RA-42)
WOLFENDEN, A., Effects of structural imperfections on voids in aluminum, 25:58298 (ORNL-TM-3493)
WOLFF, B., Measurement of $K_2^0 + 2\gamma$ branching ratio and search for $K_1^0 + 2\gamma$ decays, 25:59264
WOLFF, Sidney C., Photometry of three peculiar A-Type stars, 25:58454
WOLLENBERGER, H., Static crowdions in electron-irradiated Au-15 at. percent Ag alloys, 25:59162
WOLSKI, M., Radiographical control of thickwalled welds and castings by using of betatron, 25:57678 (INR-1204)
WOLSTENCROFT, R. D., Wavelength dependence of interstellar polarization, 25:58488
WONG, A. Y., Evolution of turbulent electrostatic shocks, 25:59020
WONG, C. W., Nuclear ground-state properties in the reaction matrix theory, 25:59851
WONG, Calvin, Spectra of fast neutrons from water pulsed with 14-MeV neutrons, 25:59674
WONG, P. Y., TOFA: a CDC 6600 computer code for torsional frequency analysis, 25:60057 (AECL-3994)
WONG, S. K. M., Simple coupling scheme for exact shell model calculations, 25:59857
WOO, Chia-wei, Sum rules for effective interactions between ^{3}He quasi particles in superfluid ^{4}He, 25:58924
WOOD, David B., Analytic model of eclipsing binary star systems, 25:58499
WOOD, E., Neutron yield from protons and deuterons in lead, 25:59820
WOOD, Edwin C., Instrumentation at Connecticut Yankee and Maine Yankee atomic power stations, 25:59899
WOOD, Robert E., Eye tumor identification tests using semiconductor detectors, 25:58064
  Medical problems in eye tumor identification, 25:58063
WOODBRIDGE, David D., Comparison of geomagnetic storms and trough development at solar-activity maximum and minimum, 25:58860
  Fluid irradiating apparatus using gamma rays and helical passageways, 25:57636
WOODY, D., Impedance matching Josephson galvanometer by means of superconducting transformer, 25:58938
WOODZICK, T. L., Investigation into the potential seismological effects of the Cannikin Event, 25:57590 (COO-2138-4)
WOOLF, N. J., Two young bright infrared objects, 25:58505
WOOLFSON, M. M., Floccule theory and planetary formation, 25:58586
WOOLHOUSE, G. R., Interaction between radiation damage and coherent precipitates, 25:59163
WOOLSEY, J. M., Absolute cross section for electron impact excitation of 3914-A N_2^+, 25:58726
WORM, Control of an installation for the impregnation and gamma irradiation of wood, 25:57628
WRIGHT, I. F., Evidence for negative parity rotational bands in ^{24}Mg, 25:59767
WRIGHT, R. F., Design for access and inspection in gas-cooled reactors, 25:60026
WU, Alfred C. T., Structure of generalized Veneziano amplitudes. I, 25:59627
  Structure of generalized Veneziano amplitudes. II, 25:59628
WU, F. J., Sum rules for effective interactions between ^{3}He quasi particles in superfluid ^{4}He, 25:58924
WYART, J. F., Present state of analysis of Nd I and Nd II, 25:58705
WYBOURNE, B. G., Symmetry principles in atomic spectroscopy, 25:58788
WYRICK, John M., Beta--gamma directional correlation of ^{203}Hg, 25:59795

Y

YABUKI, Hideo, Measurement of U, Th in Mn nodules using fission tracks and alpha particle tracks, 25:57570
YAGI, M., Differences between reactions of gaseous CH_4 with ^{80}Br and ^{82}Br, 25:57491
  Differences between reactions of gaseous CH_3Br with ^{80}Br and ^{82}Br, 25:57492
YAKHKIND, A. K., Structure of irradiated tellurite glasses, 25:57447
YAKOVKIN, N. A., Helium radiation in prominences, 25:58604
YAKOVLEV, G. N., Separation of actinides and lanthanides on Zr phosphate. II, 25:57551
  Separation of actinides and lanthanides on Zr phosphate. I, 25:57550
YAKOVLEV, R. M., Nonrelativistic particles produced in interactions of multicharged cosmic ray nuclei with light nuclei of emulsion, 25:59274
YAKUTOVICH, M. V., Thermophysical properties of yttrium above 20°C, 25:58225
YAMADA, Masahiro, Radiotherapy of lung cancer, 25:58137
YAMADA, Masami, Nuclei far off beta stability line and gross theory of nuclei, 25:59836 (KURRI-TR-76, pp 3-6)
YAMADA, Mitsuru, New method of quantization for various fields. I, 25:59557
YAMAGATA, Fukawa M., Antiproton--proton charge exchange and elastic scattering at 232 MeV, 25:59266 (SJÇ-P-71-1)
YAMAGATA, Taketora, Present status of automatic analysis of bubble chamber photographs, 25:57827
YAMAMOTO, Kazuko, New approximation in the calculation of collision probabilities in cluster-type fuel lattices, 25:60231
YAMAMOTO, Tadashi, Chemical analysis of the fuel solution of JRR-1, 25:57320
YAMAMOTO, Yasuo, Reaction matrix theory for cluster states in light nuclei. II, 25:59724
YAMASAKI, Takao, Effect of partial marrow shielding on hematopoietic recovery in heavily irradiated mice, 25:58124
YAMASHITA, Nobuo, Residual lesions following external high energy radiation therapy, 25:58074
YANAI, Ryoichi, Thermal and hydrodynamic transfer functions of BWR core, 25:60038
YANG, Ying-chuan, Unstable particle and a dual-cut model, 25:59439
YANIV, A., Distribution of ^{222}Rn on surface of moon, 25:58680
YANSON, I. R., Efficiency of some antioxidants in the thermooxidative degradation of irradiated polyethylene, 25:57462
  Thermostabilization of irradiated filled polyethylene, 25:57446
YANULIS, V. V., Investigation of volatilization of MgO and ZrO_2 in oxidizing atmospheres, 25:58345
YARIS, Robert, Many-body theory of autoionization, 25:58802
  van der Waals forces including exchange in small overlap region, 25:58809
YARKOVOI, E. A., Investigation of buildup region for γ-radiation from low-level sources, 25:59120
YARKULOV, U., Inelastic energy losses of slow ions in solids, 25:59124
YASKEVICH, V. S., Neutron beams from isotope neutron sources, 25:59690
YASUKOCHI, Akira, Weight change of the spleen following fractionated irradiation in mice, 25:58108
YASUKOCHI, Hiroshi, Effects of γ irradiation on ^{51}Cr-labeled red blood cells, 25:58136
YATES, A. C., New values for partial-wave electron scattering factor for elements 1 less than or equal to Z less than or equal to 57 and 72 less than or equal to Z less than or equal to 90, 25:58748
YATSIMIRSKII, K. B., Kinetic method for analyzing mixtures of rare earth elements, 25:57319
YATSULA, G. S., Trace element contents and natural radioactivity of foods in some districts of Kiev region, 25:57987
YEALLAND, R. M., Total effective scattering cross sections of HD-inert gas systems in thermal energy region, 25:58781
YEH, K. C., Interaction of internal gravity waves with the F2 layer, 25:58872
YEH, N., Precision measurement of lifetime and decay

branching ratio of Λ^0 hyperon, 25:59260
YELLOWLEES, J. M., GBR fuel pin technology, 25:58410 (BLG-456)
YIOU, F., Cross sections for the production of beryllium isotopes from the 880 MeV alpha-particle bombardment of carbon, 25:59733
YOHN, David S., Application of an indirect paired radio-iodine-labeled antibody technique to adenovirus-12 tumor serology, 25:57912
YONTS, O. C., Proposal for computer assisted data acquisition for ORNL fusion experiments, 25:59075 (ORNL-TM-3593)
YOOK, Chong Chul, Parameter sensitivity of the reactor control system by means of the root locus method, 25:60219
  Studies on the heat transfer dynamic analysis and the stability of TRIGA Mark-II reactor, 25:60164
YOON, T. S., Production of g-meson in $\pi N \to g^0 N$ charge exchange channels at 7 GeV/c, 25:59288
YOSHIDA, Minoru, Review of civil engineering problems in construction of nuclear power stations, 25:59895
YOSHIDA, Yoshikazu, Whole-body absorbed dose from x and gamma rays, 25:58004
YOSHIHARA, M., Some experimental data conflicting with the explosion model in gaseous bromides, 25:57501
YOSHII, H., Axial vector form factor of the nucleon and the quark--parton model, 25:59391
YOSHIKAWA, Hidekazu, Analysis of space-dependent dynamic properties of power reactors, 25:60240
YOSHIKAWA, M., Measurement of the plasma current distribution in a tokamak device with alpha-particles injected transverse or parallel to the toroidal axis, 25:58980 (JAERI-Memo-4531)
YOSHIMURA, M., Functional approach to dual quark models, 25:59435
  γ-radiolysis of gaseous carbon dioxide at high densities, 25:57461
YOSHIMURA, Tetsuhiko, Preparation of anhydrous uranium tetrachloride and measurements on its magnetic susceptibility, 25:57419
YOSHIMURA, Y., Optics of the 75 cm hydrogen bubble chamber. I, 25:57826 (SJC-T-71-3)
YOSHINO, Daisuke, Origin of organic matter in early solar system. III, 25:58575
YOSHIZAWA, Yasukazu, Why we study nuclei far off stability line, 25:59835 (KURRI-TR-76, pp 1-2)
YOUNG, Gale, Optimal strategies in reactor system economics, 25:60103
YOUNG, J. C., Prog. rpt. on fast reactor spectrum measurements, 5--7/71, 25:60156 (GULF-RT-A-10800)
YOUNG, K. K., Isospin invariance in reaction $np \to \pi^0 d$, 25:59268
YOUNG, Stanley G., Etching of metallographic specimens by cavitation, 25:58190
YOUNGER, S., Nuclear-particle track detection using liquid--liquid phase separation: the glass chamber, 25:57727
YOUSSEF, S. K., Assay efficiency and response for cylindrical scintillation crystals and large-area gas counters applied to whole-body counting, 25:57772
YUASA, Yoichi, Experimental fast reactor Joyo, 25:60188
YUDIN, D. M., Structure of irradiated tellurite glasses, 25:57447
YUFEROV, V. B., Heating of a hot plasma created by an electron beam, 25:58972
YUMASHEVA, M. A., Morphological study of organs, blood cells, and bone marrow of white rats and mice with vaccinal disease, 25:58128
YURENAS, V. L., Statistical methods of determining the thermal-shock resistance of refractories, 25:58376
YUSIPOV, V. S., Change in the level of redox potential in muscles of different animal species as a function of the dose of cystamine introduced, 25:58031
YUSUPOVA, D. Yu., Effects of heat treatment and γ irradiation on photodeformation effect in Ge, 25:59128
YUZHINA, A. D., Ion exchange fibers and fabrics. II, 25:57555
YVARS, M., Development of properties of nuclear graphite obtained by a mixture of cokes, 25:58366 (CEA-CONF-1820)

Z

ZABYALENDZIK, S. F., Phosphorus feeding of buckwheat and yellow lupine, 25:57949
ZADUBAN, M., Possibilities of rapid separation of radioiodide, radioiodate, and radioperiodate, 25:57559
  Separation of radioiodide from simulated biological samples by isotopic exchange in a heterogeneous system, 25:57367
ZADUMKIN, S. N., Surface energy and work function of the smooth faces of a metallic single crystal, 25:59194
ZADVORNYI, A. S., Gamma-activation method for determining carbon and oxygen in beryllium, 25:57385
ZAFIRATOS, C. D., New (p,n) reaction studies at Ep = 23 MeV, 25:59789
ZAGIEBOYLO, W., Electron irradiation of dilute aqueous solutions of polymers, 25:57443
ZAGORSKI, Zbigniew P., Changes of Dextran 40000 irradiated with γ radiation, 25:58160
ZAIKOVSKAYA, M. A., Comparative characteristics of subthreshold radiation effects in n- and p-type Silicon, 25:59127
ZAITSEV, L. N., Activation of concrete shield of OIYaI synchrocyclotron, 25:59657
ZAITSEVA, N. G., Behavior of radioactive Re atoms in thermal annealing of crystalline Re salts, 25:57497
  Fast thermochemical methods of separation of radioactive elements. I, 25:57480 (JINR-P6-5955)
ZAKHAROV, A. M., Study of the molybdenum--zirconium--carbon system, 25:58273
  System molybdenum--nickel--carbon, 25:58290
ZAKHAROV, L. E., Effect of equilibrating magnetic field on plasma cross section, 25:59077
ZAKHAROV, S. I., Purification of the coolant water by distillation, 25:60064
ZALEWSKI, K., Decays of interfering resonances and statistical tensors, 25:59461
ZANDRON, O., Axial-vector form factors from current algebra Regge poles and Veneziano model, 25:59356
ZANFAGNA, B., Nonlinear harmonic generation in a thermal magnetized plasma, 25:59013 (CEA-CONF-1835)
ZANG, Thomas A. Jr., Efficient Monte Carlo event generation method for multiperipheral models, 25:59213
ZAOZERSKAYA, L. A., Pulse-radiolysis studies of some nucleic acid fragments in aqueous solutions, 25:57930
ZAPESOCHNI, I. P., Excitation and ionization by electrons, 25:58741
ZARUBIN, Yu. V., Temperature effect in 20 to 250°C range for certain, strictly regular, heterogeneous, U--H_2O critical assemblies, 25:60161
ZASIMCHUK, E. E., Structure of anomalously coarse grains in secondary recrystallization of tungsten foils, 25:58279
ZASTAVENKO, L. G., Vacuum degeneration for charged scalar field, 25:59576
ZASTENKER, G. N., Velocity and temperature of solar wind, 25:58613
ZATSEPIN, G. T., Analysis of neutrino experiments in cosmic rays, 25:59417
ZAVADOVSKAYA, E. K., Electric conductivity of electron-irradiated monocrystals of KCl--RbCl solid solutions, 25:59172
ZAYACHKI, V. I., pp and pd elastic scattering at 50 and 70 GeV, 25:59273
ZAZIMKO, E. A., Polarographic determination of Bi, Cu, Pb, Cd, Zn as impurities in rare earth preparations, 25:57311
ZDANUK, E. J., Influence of additives on the formation of periodic precipitation (Liesegang bands) in the Ag--Cd system, 25:58262
ZDRAVKOVIC, M., Spatial temperature field of a concrete vessel, 25:60080
ZEHAVI, D., Effect of thallous ions on the yields of hydrogen and hydrogen peroxide in radiolyzed aqueous solutions, 25:57472
ZEIBIG, H., Reliability requirements for nuclear power plants, 25:60122
ZEIDLER, U., Calculation, construction, and testing of collimators used for scintigraphy with low-energy radionuclides, 25:57891
ZELDINA, M. Yu., Helium radiation in prominences, 25:58604
ZEL'DOVICH, Ya. B., Scattering, reactions, and disintegrations in nonrelativistic mechanics, 25:59612
ZEMKE, Warren T., sigma--π separation: excited H_2 as a model system, 25:58711
ZEMLO, L., Reactions (n,α) on heavy nuclei induced by 14.2-MeV neutrons, 25:59802
ZEMSKOVA, M. G., Emission-spectral and radioactivation analysis of yttrium oxide with preliminary concentration of rare earth impurities by extraction chromatography, 25:57372
ZERBI, G., Normal coordinate analysis of ethyl chloride and some deuterated derivatives, 25:57422
ZEYFANG, E., High-current hollow-cathode ion sources, 25:59080
ZGRABLICH, G., Double-peaked distributions and their relation to fireballs, 25:59529
ZHEGALINA, G. A., High-sensitivity thermally stimulated exoelectron emission element for gamma dosimeters, 25:57836
ZHEMEREV, A. V., γ-ray induced scintillation, 25:59119
ZHILKINA, S. P., Determination of cerium in refractory alloys with use of chromatographic separation, 25:57338
ZHIZHIN, E. D., Angular and momentum distributions of μ^+ mesons from W^+-boson decay in reaction ν/sub μ/ + Z → μ^- + Z + W^+, 25:59413
  Angular and momentum distributions of μ^- mesons in reaction $\nu + Z \to \mu^- + W^+ + Z$, 25:59414
ZHUKOVA, E. G., Mechanical properties of molybdenum-base alloys, 25:58248
ZHUKOVSKAYA, L. P., Preparation of gas samples from carbonates and their solutions for measurements of activity of ^{14}C, 25:57358
ZHUKOVSKII, V. Ch., Compton effect and induced Compton effect in constant electromagnetic field, 25:59368
ZHURAVLEV, V. F., Toxicity of tritium oxide for animals, 25:57916
ZIEGLER, Donald L., Evaluation of methods to recover plutonium from incinerator ash, 25:57525 (RFP-1723)
ZIELCZYNSKI, M., Quality factor of radiation, 25:58005
ZIFF, Robert, Flow dissipation equation in liquid He II,

25:58927
ZIMEN, K. E., Nuclear energy reserves and long-term energy requirements, 25:60020
ZIMERMAN, A. H., Some exact inequalities involving S and P waves and their derivatives for πK scattering, 25:59452
ZIPF, E. C., Excitation of vuv emission features by electron impact on molecular gases. I, 25:58728
ZIRILLI, F., Angular correlations of the decay products of two heavy leptons, 25:59390
ZIRIN, H., Magnetic fields, bremsstrahlung, and synchrotron emission in flare of Oct 24, 1969, 25:58609
ZLATANOV, Z. M., pp and pd elastic scattering at 50 and 70 GeV, 25:59273
ZOLOTAVIN, V. L., Deactivation of radioactive sewage by the method of two-step coagulation of ferric hydroxide, 25:57556
ZOMMERFEL'DT, Kh., Energy dependence of secondary-electron emission in crystals, 25:59146
ZOREV, N. N., Investigation of the laser initiated discharge spark channel, 25:59076 (UCRL-Trans-10556)
ZOTOV, N. P., Reaction $\pi^-p \to$ etan and universality of complex trajectories, 25:59479
ZOTOVA, L. M., Weldability and corrosion resistance of titanium--5 percent tantalum alloy, 25:58176
ZSOLDOS, L., Use of isotopes and radiation techniques in horticulture, 25:57911
ZUBENKO, Yu. V., Adsorption and desorption of ytterbium on carbonized tungsten, 25:58228
ZUCKER, A., Elastic scattering of 40-MeV protons from ^{48}Ti, /sup nat/Cr, and ^{64}Zn: tabulated differential cross sections, 25:59739 (ORNL-TM-3591)
ZUCKER, Paul Alan, Relativistic model for the electro- and weak production of nucleon resonances, 25:59337
ZUEVA, I. B., Recrystallization and carbide phase formation processes in molybdenum base alloys, 25:58282
ZUFFI, L., Analysis of 14.1 MeV neutron scattering from ^{11}B, 25:59720
  SASSI: FORTRAN program for calculation of neutron scattering from a spherical optical potential, 25:59842 (RT/FI-(71)6)
ZUKER, A. P., Simple coupling scheme for exact shell model calculations, 25:59857
ZULEEG, R., Improved fast neutron tolerance of GaAs JFET's operating in the hot electron range, 25:57905
ZUM WINKEL, Karl, Clinical importance of the study of the lymphatic system with radioisotopes, 25:58055
ZUPRANSKI, P., Compound nucleus formation in reaction ^{3}H(d,n)^{4}He, 25:59706
ZUR NEDDEN, P., Acidic organodiphosphorus extractants. V, 25:57544
  Dissociation constants of double complexes of type MeY_2H/sub n//sup (3-n)/-, 25:57537
ZUTZ, Lothar, Manufacture of fuel elements for reactor at Grosswelzheim, 25:58205
ZUZAK, W. W., Similarity models of interstellar loop structures, 25:58640
ZWEIFEL, P. F., Multigroup transport equation with a separable kernel, 25:59111
ZWIEGLINSKI, B., Reactions ^{9}Be(d,α_0)^{7}Li (ground state) and ^{9}Be(d,α_1)^{7}Li* (470 keV), 25:59721
ZYLICZ, J., Decay scheme of ^{232}Pa, 25:59798
  Levels of ^{230}Th and ^{230}U fed in decay of ^{230}Pa, 25:59800

SUBJECT INDEX

Cross references are included in cumulative subject indexes and in *Subject Headings Used by the USAEC Division of Technical Information* (USAEC report TID-5001).

The reader is also referred to *Guide to Abstracting and Indexing for Nuclear Science Abstracts* (USAEC report TID-4576).

Most headings in the subject index are specific materials, things, and processes. The headings are followed by modifiers that describe the properties of, or processes applied to, the headings.

All index entries cite *NSA* volume and abstract numbers; volume number precedes the colon and the abstract number follows it. The designation (R) following the abstract number indicates a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Report numbers, where applicable, are included in parentheses after the abstract number of the citation. Published literature (journal article or book) can be identified by the absence of a report number.

Ideas presented in the original literature, rather than key words, have been indexed. The indexers have selected what seemed the most probable and logical place to look for typical information. Since it is not always possible to anticipate where a user would look for information, the cumulative indexes include numerous cross references. Consideration of synonymous or closely related terms will prove valuable.

Information is indexed for the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use or to the general class headings that include the specific headings. For example, information on boiler design for the Fermi Fast Breeder Reactor would be indexed under the headings BOILERS and FERMI FAST BREEDER REACTOR but not necessarily under the headings REACTORS, FAST or REACTORS, BREEDER.

General or broad headings are reserved for general summaries, reviews, comprehensive reports, and similar literature.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings; e.g., AMINO ACIDS rather than ACIDS, AMINO; HELIUM ISOTOPES He-4 rather than HELIUM—ISOTOPES He-4 or HELIUM—He-4 ISOTOPES. Note, however, that in some cases parenthetic modifying terms or inverted headings such as NEUTRONS, FAST, are used where the alphabetical arrangement of a direct entry would cause information to be scattered. In addition, organic compounds are usually entered in the index in the inverted form to facilitate grouping like or related compounds with the parent compounds; e.g., BENZENE, BROMO- rather than BROMOBENZENE. In general, the nomenclature used is that of the subject indexes to *Chemical Abstracts.*

Alphabetization

Subject headings are alphabetized word by word. Parenthetic qualifiers, numbers, and Greek letters within subject headings are disregarded in alphabetizing unless there are two or more headings that are otherwise identical, in which case the qualifier, numerical progression, or spelled names for the Greek letters determine the order.

Examples:

```
M-Capture
  see ELECTRON CAPTURE
MAGNESIUM
MAGNESIUM ALLOYS AND SYSTEMS
MANGANESE FLUORIDES
MANGANESE FLUORIDES MnF2
MESONS
MESONS (π)
MESONS (ρ)
1-PENTANOL
2-PENTANOL
```

Modifying Phrases

The modifiers appearing under a subject heading are written specifically to show the relation between the item being indexed and the heading. The modifier therefore contains a maximum of useful information. Although the modifier begins with the word judged to be of greatest use to the greatest number of users, there is still need for the searcher to consider all modifiers under the heading(s) of interest.

Modifiers usually form meaningful phrases when combined with the subject heading. Some are intended to be read following the subject heading, e.g., the entry HYDROGEN—sorption by charcoal should be read "hydrogen sorption by charcoal." As a result of placing the important word first, however, many modifiers must be rearranged for smooth reading, e.g., FORMALDEHYDE—yields in radiolysis of ethyl ether, effects of deuterium on, should be read "effects of deuterium on formaldehyde yields in radiolysis of ethyl ether" and URANIUM—crystal structure of, effect of cooling rate on allotropic transformations in, should be read "effect of cooling rate on allotropic transformations in crystal structure of uranium."

Special characters are added to modifiers in the fields of physics and reactor technology; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the abstract number.

Physical States and Configurations of Materials

The specific physical state, if other than normal, or the geometric configuration of the material is included in the modifying phrase; e.g., information on liquid metals is indexed under the specific metal with "liquid" in the modifier and carbon crucibles is indexed under CARBON with "crucibles" appropriately placed in the modifier. The information on carbon crucibles is also indexed under CRUCIBLES.

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed to subject headings in the direct form. Cations are listed in the order of increasing valence for polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., SODIUM ALUMINUM SILICATES and POTASSIUM SODIUM SULFATES. If more than one anionic species is presented in a compound, the anions are arranged alphabetically, e.g., BERYLLIUM FLUORIDE HYDROXIDES.

Nomenclature of Organic Compounds

Organic compounds are indexed by subject headings based on the indexes to *Chemical Abstracts* except in the area of enzymes, in which specific enzymes, named according to the 1964 recommendations of the International Union of Biochemistry, are used. In many cases nonproprietary names for drugs are used as subject headings, and cross references are made from the systematic chemical names. Subject headings for hormones appear in the inverted style at HORMONES.

Nomenclature of Life Sciences

Subject headings for plants are names of phyla with one exception: members of the Phylum Tracheophyta are indexed under class or subclass names. Scientific names (genus and species) are used as the initial, or file, word in the modifying phrase. Scientific names are omitted only when the name is not available in the literature or cannot be found in available references.

Subject headings for animals are the names of phyla with the following exceptions: (1) members of Phylum Arthropoda and Phylum Chordata are indexed under appropriate class name, and (2) common names are used for members of Class Mammalia.

Subject headings are entered for various classes of commodities, and specific products are identified in the file-word position of the modifier. In the following examples, approved subject headings are capitalized and typical modifier file words are listed in lower case.

Example 1	Example 2
CEREALS	MEATS
bread	beef
flour	fish
oats	mutton
rice	pork
rye	poultry
wheat	seafood

Diseases, pathological conditions, and in vitro studies of atypical cells and tissues are indexed under subject headings for the organism affected, under the appropriate anatomical structure of physiological phenomenon affected, and under the appropriate disease heading. Subject headings for diseases (defined as any deviation from the norm) are DISEASES; DISEASES, INFECTIOUS; DISEASES, NEOPLASTIC; DISEASES, PHYSIOLOGICAL; DISEASES, PLANT; and DISEASES, TRAUMATIC.

Diseases of mixed etiology are treated in the following manner: neoplastic diseases that are also classified as infectious or physiological are indexed under DISEASES, NEOPLASTIC; diseases in which a microorganism is the etiologic agent are classified under DISEASES, INFECTIOUS; physiological anomalies that are neither neoplastic nor infectious are indexed under DISEASES, PHYSIOLOGICAL; the acute radiation syndrome, nonspecific radiation injuries, trauma, and wounds or incisions inflicted mechanically are indexed under DISEASES, TRAUMATIC.

Specific diseases or pathological conditions are named in the file-word position of the modifier, in the author's terminology, and are set off from the remainder of the modifier by commas. Neoplasms are designated as benign or malignant in the file-word position when more specific information is not available.

Multicomponent Alloys and Other Systems

Multicomponent alloys and systems, except well-known trade names, are indexed under a subject heading for each component in the form "element systems" for nonmetals or "element alloys and systems" for metals. The modifier begins with element symbols for each component arranged alphabetically. In addition, if significance is placed on the base metal of the alloy, this is indicated by adding "-base" to the element symbol.

Example: A 1.5C, 12Cr, 0.25V, 0.8Mo, bal Fe alloy is indexed as

```
CARBON SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
CHROMIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V,...
IRON ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
MOLYBDENUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
VANADIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
```

Well-known alloys, such as ZIRCALOY-2, are indexed under the trade name; cross references from each component of the alloy to the trade name appear in cumulative indexes.

Multicomponent systems in which nonmetallic elements are present in large percentage and which are commonly referred to as systems or mixtures are indexed in a manner similar to alloys.

Example: A tungsten–silicon preparation is indexed as

```
TUNGSTEN ALLOYS AND SYSTEMS
  Si--W, ...
SILICON SYSTEMS
  Si--W, ...
```

Multicompound systems and mixtures of inorganic compounds are indexed under the subject heading for each component compound; the modifiers begin with an alphabetical listing of compound formulas.

Example: A lead titanate–lead zirconate mixture is indexed as

LEAD TITANATES
  $PbTiO_3$ --$PbZrO_3$
LEAD ZIRCONATES
  $PbTiO_3$ --$PbZrO_3$

A mixed system of compounds and elements is indexed by a combined form of the preceding conventions; e.g., a dispersion of copper and alumina would be indexed as

ALUMINUM OXIDES
Al_2O_3--Cu, ...
COPPER ALLOYS AND SYSTEMS
Al_2O_3--Cu, ...

Mixtures of organic compounds are indexed under subject headings for each component of the mixture; the modifiers begin with an alphabetical listing of compound names.

Example:

ACETIC ACID
acetic acid--BF_3, ...
BORON FLUORIDES
acetic acid--BF_3, ...

Example:

BENZENE, CHLORO-
bromophenol--chlorobenzene, ...
PHENOL, BROMO-
bromophenol--chlorobenzene, ...

If modifiers for alloys and systems are included with other modifiers under the same subject heading, they are filed last.

Example:

CARBON SYSTEMS
deposition on nuclear fuel
particles
molecular structure of
neutron total cross section for
sorptive properties for xenon
Young's modulus for
Al--C--Cr, superconductivity in
B--C, phase studies for
C--U--Zr, fabrication and
physical properties of

Nomenclature of High Energy Physics

Information on particle-particle events is indexed under subject headings for the specific particles involved. The modifier file word *interactions* is followed by the specific interaction written in symbolic form. Particle nomenclature and symbols follow that of Rosenfeld, et al. *Data on Particles and Resonant States,* UCRL-8030 (latest revision). For consistency the incident particle is always written first. The mass (in MeV) of a resonance state is included in parentheses after the symbol to avoid ambiguity. Hyperfragments are indicated in modifiers as in the following examples: Λ-He^5, Σ-H^3, $\Lambda\Lambda$-Be^{10}. The superscript on the right indicates the total number of baryons in the composite system.

Examples:

MESONS (π^-)
interactions $\pi^- + p \rightarrow \Lambda + K^+ + \pi^-$ at 6 GeV/c in
hydrogen bubble chamber, ΛK(1700) enhancement
in, (E)
BARYONS, RESONANCE (N*)
production of Δ^{++}(1236) and Δ^0(1236) from $K^- +$
$p \rightarrow K^- + p + \pi^+ + \pi^-$ interactions at 2.63 and
2.70 GeV/c, (E)
HYPERFRAGMENTS
binding energy of $\Lambda\Lambda$-He^6, three-body α--Λ--Λ
model for

Subject headings are also provided for specific models and theories.

Examples:

ELEMENTARY PARTICLE MODELS (TRIPLET)
hadron total cross sections in quark, numerical
analysis of
CURRENT ALGEBRA
PCAC hypothesis for A_1 and rho dominance in $\pi \rightarrow$
$e + \nu + \gamma$ decay
REGGE POLE THEORY
predictions for polarization in $K^- + p \rightarrow$ anti
$K^0 + n$, $\pi^- + p \rightarrow \pi^0 + n$, and $\pi^- + p \rightarrow$ eta $+ n$
interactions at high energies
SYMMETRY GROUPS
SU(2) × SU(4) intermediate-coupling model for
nucleon and hyperon isobars

Nomenclature of Reactor Technology

Subject headings for reactors are of three types:

(1) Specific reactors, e.g., ARGONNE RESEARCH REACTOR, SAXTON POWER REACTOR

(2) Reactors having a common physics or engineering characteristic, e.g., REACTORS, FAST; REACTORS, ORGANIC-COOLED; REACTORS, PRESSURIZED-WATER

(3) Reactors having a common purpose, e.g., REACTORS, POWER; REACTORS, RESEARCH

Information on specific reactors, type (1), is indexed under the one specific subject heading. Information on classes or types of reactors, types (2) (characteristics) and (3) (purpose), is indexed under all applicable headings. For example, information on a heavy-water-moderated organic-cooled power reactor is indexed under REACTORS, HEAVY WATER-MODERATED; REACTORS, ORGANIC-COOLED; and REACTORS, POWER.

Subject headings exist for selected reactor components, e.g., REACTOR FUEL ELEMENTS. When applicable, headings for components are indexed even though they may have been included in a modifier under a type (1) or (2) heading. The materials in reactor components are indexed when the information is peculiar to the material.

Modifier file words under reactor headings are of two primary types: one type expresses reactor characteristics, e.g., reactivity; the other, components, e.g., control rod. If no subject heading appears for a reactor component, the heading REACTORS is used, and the component is used as the modifier file word.

A

- ACCELERATOR TUBES
  - circuit for, transformer, 25:59648(P)
- ACCELERATORS
  - developments in, review on, 25:59650
  - targets for, preparation methods for isotopic, 25:59636 (CONF-711002-, pp 101-7)
- ACCIDENTS
  - management of radiation, program for regional medical facilities for, 25:58039
- ACETAMIDE, 2-IODO-
  - radiosensitizing effects on ascites tumor cells in mice, effects of oxygen on, 25:58034
- ACETIC ACID
  - analysis of analytical grade, for impurities by neutron activation, 25:57379
- ACETIC ACID, [(CARBOXYMETHYLIMINO)BIS(ETHYLENENITRILO)]TETRA-
  - complexes with praseodymium, separation processes based on, 25:57549
  - complexes with thorium, structure of, ir and proton NMR spectral studies of, 25:57436
  - effectiveness for removing cobalt-60 from skin in comparison to EDTA and polycomplexon, 25:57982
  - effects on excretion of plutonium-239 by rats, 25:57998 (NIRS-Pu-8)
- ACETIC ACID, (ETHYLENEDINITRILO)TETRA-
  - effectiveness for removing cobalt-60 from human skin in comparison to DTPA and polycomplexon, 25:57982
  - tetrasodium salt, radioprotective effects on bacteriophages, γ and uv, 25:58032
- ACETIC ACID, PHENYL-
  - complexes with p-hydroxybenzoic acid and uranyl ions, stability of, 25:57402
- ACETIC ACID, VINYL ESTER
  - reactions with solvated electrons, rate constant of, 25:57475
- ACETYLENE
  - yields from γ radiolysis of gaseous ethylene in presence of 2-methylpropene, 25:57474
- ACID PHOSPHATASE
  - radiation effects on activity in rat nervous system, x, 25:58098
- ACOUSTIC EMISSION TESTING
  - method for welded joints in reactors, 25:57680 (ORNL-TM-3561)
- ACRYLAMIDE
  - reactions with solvated electrons, rate constant of, 25:57475
- ACRYLIC ACID, ETHYL ESTER
  - reactions with solvated electrons, rate constant of, 25:57475
- ACRYLIC ACID, METHYL ESTER
  - reactions with solvated electrons, rate constant of, 25:57475
- ACRYLONITRILE
  - reactions with solvated electrons, rate constant of, 25:57475
- ACTINIDES
  - energy levels of, description of 0^+ pairing, (T), 25:59809
  - position in periodic table, theory based on analog lines and principle of incompatibility for, 25:57438
  - separation by paper or thin-layer chromatography, 25:57553
- ACTINIUM
  - electromigration behavior of, in CDTA and EDTA, 25:57520 (JINR-E6-5952)
- ACTIVATION ANALYSIS
  - bibliography on, 25:57368 (AED-C-14-5)
  - equipment and method for automated one-element instrumental, 25:57390
  - equipment for neutron, for determination of mineral content in man, 25:57785
  - facilities for neutron, gamma spectrum calculations for material selection for, 25:57796 (ORNL-TM-3457)
  - sensitivity of proton, for light elements in surface layers, 25:57396
  - sensitivity of, effects of slowing down neutrons in sample on, 25:57377
  - separation method for neutron, electrochemical preconcentration, 25:57393
  - uses of continuous neutron, in analytical control, review on, 25:57388
- ADENOSINE MONOPHOSPHATES
  - effects on survival of uv-irradiated KB cells, 25:58087
- ADENOSINE 5'-TRIPHOSPHATE
  - radiation effects on activity in liver mitochondria of rats, radon, 25:57932
  - radiation effects on content in rat liver, x, 25:57936
- ADRENAL GLANDS
  - effects of cortex extract of, on radiosensitivity of man following therapy for cervical cancer, 25:58035
  - radiation effects on activity in rats, bremsstrahlung, 25:58107
- AEROSOL GENERATORS
  - development of plutonium, 25:57998 (NIRS-Pu-8)
- AEROSOLS
  - distribution of accident released, in liquid metal coole reactor containment, (E/T), 25:60148 (AI-69-Memo-95)
- AGE
  - effects on frequency of x radioinduced mutations in germ cells of male mice, 25:57967
  - effects on incidence of deoxycitidinuria among uranium mining personnel, 25:58145
- AGRICULTURE
  - radioisotopes in, in Hungary, 25:57911
- AIKEN AREA (S.C.)
  - radiation monitoring during 1970, 25:57993
  - radiation monitoring during January through June 1971, 25:57996(R) (DPSPU-71-30-16)
  - radioactivity monitoring during 1969, 25:57985
- AIR
  - flow through concentric circular ducts separated by porous pipe, (E/T), 25:57645
  - heating by stabilized electric arcs at high pressure, characteristics of, (T), 25:59059
  - particles in French uranium mine, concentration and size of, (E), 25:57564
  - photon reactions with, scintillation induced by, 25:59119
  - air--H_2O, flow in vertical channels, gamma attenuation method for measuring void fraction in, 25:57648
- AIR LOCKS
  - door pairs for reactor containment structure, coupled fastening mechanism for, 25:60257(P)
- AIR SAMPLERS
  - design for monitoring plutonium-239 in laboratories, 25:57998 (NIRS-Pu-8)
- AIRCRAFT
  - radiation dose to man during travel on high-altitude supersonic, ionizing, 25:58138
- AIRGLOW
  - morphology of 6300-A, associated with nighttime F-region molecular ion density, (E/T), 25:58884
  - spectral emission in night, spectrophotometric data from Jan.-Mar., 1968 and Nov.-Dec., 1969, (E), 25:58883
  - spectral emission variations of (4-1) and (5-2) hydroxyl bands in night, Calgary data of seasonal and diurnal, (E), 25:58902
- ALANINE AMINOTRANSFERASE
  - radiation effects on activity in mitochondria of brain, liver, and heart of adrenalectomized rats, x, 25:57933
- ALARM SYSTEMS
  - design for accidental nuclear excursions, 25:57780
  - design of radiometric fire detection system, 25:57873(P)
- ALASKA
  - seismic activity of Amchitka Island region of, effects of Milrow Event on, 25:57597
- ALKALI METAL HALIDES
  - radiolysis of crystals of, role of external surface in, 25:57464
  - vacancies in, formation energies for individual, 25:60281 (ORO-3344-4)
- ALKALI METALS
  - electron reactions with, excitation and ionization in, (E), 25:58741
- ALKANES
  - beta-particle reactions with, mean energy loss per ion pair formed in, (E), 25:59122
  - surface tension of mixed, effects of composition on, 25:58387(R) (ANL-7823)
- ALKENES
  - radioinduced luminescence in alkane glasses, γ, 25:57463
- ALLENE
  - yields from γ radiolysis of gaseous ethylene in presence of 2-methylpropene, 25:57474
- ALLOYS
  - analysis for cerium following chromatographic separation from interfering metals, photometric, 25:57338
  - physicochemical properties of solid, effects of ionic heating during diffusion welding on surface, 25:58233
  - radioinduced void formation in, conference on, 25:58304
  - radioinduced void formation in, review of fast neutron, 25:58305
- ALPHA PARTICLES
  - absorption by materials used in nuclear measurements, material assay by, 25:59640 (CONF-711002-, pp 272-82)
  - detection and discrimination from recoil protons in nuclear emulsions, processing method for, 25:57731
  - effects on electric conductivity of aluminum foils, analysis of recovery stages from, 25:59158
  - effects on ESR and optical transmission spectra of α-silicon carbide monocrystals, 25:59154
  - effects on germanium monocrystals in magnetic field, electric potential induced in, 25:59143
  - effects on rhenium at 5°K, annealing of, 25:59142
  - effects on stress rupture of Types 304 and 316 stainless steel, 25:58163(R) (AI-AEC-12859)
  - effects on tensile properties of IN-102 and Inconel 625, 25:58163(R) (AI-AEC-12859)
  - effects on tensile properties of vanadium-base alloys, 25:58163(R) (AI-AEC-12859)
  - emission from mixed plutonium isotopes, proportional counter measurement of, 25:57998 (NIRS-Pu-8)
  - reactions (α,n) in plutonium carbide and plutonium dioxide, Hauser-Feshbach calculation of neutron spectra from, 25:59708 (BNWL-B-109)
  - reactions (α,n) with carbon-13 and oxygen-17 and -18 at 1 to 5.5 MeV, excitation functions and Hauser--Feshbach

calculations of spectra from, (T), 25:59708 (BNWL-B-109)
reactions (α,p) with magnesium-24, p-γ angular correlations from, (E), 25:59761
reactions with carbon at 880 MeV, cross sections for production of beryllium-9 and -10 in, (E), 25:59733
reactions with light nuclei at low energies, cross sections and polarization effects in nucleon transfer, (T), 25:59831 (IFA-CRD-41)
scattering by lead-207 at 18 MeV with Coulomb excitation, gamma spectra from inelastic, (E), 25:59804
scattering by natural lead at 15 MeV with Coulomb excitation, gamma spectra from inelastic, (E), 25:59804
scattering by samarium-152 and -154 at 10 to 12 MeV with Coulomb excitation, cross sections for inelastic, (E), 25:59823
scattering by spinless nuclei, Regge-pole and partial-wave analysis of glory scattering in backward elastic, (T), 25:59846

ALPHA SOURCES
determination in biological materials, alpha spectra unfolding method for, 25:57362
determination in urine, methods used at CNEN for, 25:57347 (RT/PROT-(71)9)
separation from radioactive sewage by coagulation with ferric hydroxide, 25:57556

ALPHA SPECTROMETERS
data unfolding method for ionization, for determination of alpha sources in biological materials, 25:57362
fabrication and testing of indium antimonide and lead oxide, 25:57807
performance of surface-barrier silicon, 25:57794 (INS-TCH-5)

ALUMINUM
activity in aluminum--titanium alloys, effects of hydrogenation on, 25:58220
bonding to lead telluride, methods for solid-state, 25:58207
bonding to stainless steel, method for diffusion, 25:58207
bonding to uranium fuel tubes, method for diffusion, 25:58207
determination by extraction using quinolinol melt and spectrography, 25:57312
determination in JRR-1 coolant water, 25:57320
determination in Roanoke River water by neutron activation and γ spectrometry, 25:57395
effects on complexonometric determination of rare earths, 25:57317
effects on periodic precipitation in silver--cadmium alloys, 25:58262
effects on thermostability of irradiated polyethylene, 25:57446
electron reactions at 12.5 to 22 MeV with, bremsstrahlung yield from, 25:59106
etching of, mechanism studies on, 25:58244
heat transfer to contacting aluminum surfaces, temperature wave method for measurement of, 25:57644
heat transfer to contacting iron surfaces, temperature wave method for measurement of, 25:57644
helium-ion reactions at 45 to 90 keV/amu with, helium-isotope dependence of cross sections for K-shell ionization in, (E), 25:58776
mechanical properties of, effects of fatigue on, 25:58223
microstructure of, effects of fatigue on, 25:58223
photon reactions at 560 MeV, emulsion study of dependence on atomic weight for yields of π^+ and π^- from, (E), 25:59248
photon reactions with, secondary electron emission from, (E/T), 25:59107
proton stopping power at 20 to 1000 keV of, electronic, (T), 25:59124
radiation effects on anelastic properties of, effects of cold-working and annealing on neutron, 25:58338
radiation effects on electric conductivity of analysis of recovery stages from alpha-particle, 25:59158
radiation effects on void distribution in, relations of dislocations and impurities with neutron, 25:58298 (ORNL-TM-3493)
radiation effects on, relations of chromium, copper, and vanadium contents on recovery from fast neutron, 25:58303
radioinduced failures of tubing of, in ORNL 86-inch cyclotron, 25:59643 (ORNL-TM-3523)
radioinduced point defects in, effects of annealing on Stage I recovery from electron, 25:58341
radioinduced void formation in high-purity, effects of fluence and flux on fast neutron, 25:58311
radioinduced void formation in, fast neutron, 25:58310
spin-state mixing in superconducting, 25:58943
void formation in, by deformation, 25:58319
welding to steel, deposition of intermediate layers for, 25:58204

ALUMINUM ALLOYS AND SYSTEMS
Al--H, neutron diffusion constants for, (T), 25:59687
preparation of reference specimens of, methods for, 25:58179 (CONF-711002-, pp 47-58)
Ag--Al--In, phase studies at 143 to 506°C, isothermal, 25:58287
Al--B, fracture in continuous monolayer and bilayer composites of, microradiographic studies of, 25:58400
Al--BN, preparation of metal--matrix composites of, methods for, 25:58363
Al--C, preparation of metal-matrix composites of, methods for, 25:58363
Al--Co--Cu--Fe-base--Ni, properties and structure of, effects of neodymium additions on, 25:58250
Al--Cr--Mo--W, development of cast, for turbine blades, 25:58203
Al--Cr--Ni-base--Ti, radiation effects on mechanical properties of, relations of temperature with neutron, 25:58295 (FRNC-TH-64)
Al--Cu, creep strength of, effects of zirconium additions on, 25:58239
Al--Cu, welding to steel, deposition of intermediate layers for, 25:58204
Al--Cu-base, oxidation at high temperatures, mechanisms of, 25:58171
Al--Cu-base--Si, oxidation at high temperatures, mechanisms of, 25:58171
Al--Ge--Nb, properties of superconducting, 25:58948
Al--Mn, structure of drops of, formed at high cooling rates, 25:58284
Al--Mo, structure of drops of, formed at high cooling rates, 25:58284
Al--Nb--Ni, preparation of fiber-strengthened composites of, method for, 25:58363
Al--Ni, void formation in intermetallic NiAl single crystals, relations with microstructure, 25:58318
Al--Ni-base, stability of intermetallic compounds and solid solutions in, thermal, 25:58224
Al--SiC, properties of carbide whisker reinforced composites of, 25:58361
Al--Sn--Ti-base--V, heat treatment of, using molten glass, 25:58199
Al--Ti, aluminum activity in, effects of hydrogenation on, 25:58220
Al--Ti-base--V, bonding of, method for diffusion, 25:58207
Al--Ti-base--V, drawing of, testing of lubricants for deep, 25:58195
Al--Ti-base--V, extrusion of thin-walled tubes of, development of method for, 25:58199
Al--Ti-base--V, rolling of sheets of, development of method for, 25:58199
Al--U-235, criticality parameters of hollow cylinders in water, (E/T), 25:60212
Al--W, structure of drops of, formed at high cooling rates, 25:58284

ALUMINUM ISOTOPES Al-27
deuteron elastic scattering at 80 MeV, optical-model analysis of angular distributions from, (E), 25:59754
energy level at 0.84 MeV from magnesium-24 $(\alpha,p\gamma)$ reactions, lifetime for, (E), 25:59751
energy levels from carbon-12 (O-16,p) and magnesium-24 (α,p) reactions, high-spin, (E), 25:59761
energy levels from carbon-12 (O-16,p) reactions, high-spin, (E), 25:59714
neutrino scattering by, weak nucleon processes for impulse approximation for quasielastic forward, (T), 25:59397
neutron elastic and inelastic scattering at 7.96 and 9.05 MeV, cross sections for, (E/T), 25:59770
proton reactions (p,γ) near 1 MeV, precise γ-ray energies and Q-value for, (E), 25:59762
proton reactions at 6 to 52 MeV, cross sections for aluminum-26 and sodium-22 formation in, (E), 25:59753

ALUMINUM NITRIDES
effects on radioinduced polymerization of benzene or toluene, 25:57456
AlN--BN, thermal conductivity of sintered compacts of, at 1000 to 1600°C, 25:58385

ALUMINUM OXIDES
effects of doping agent of, on fission product retention by uranium oxide fuel particles, 25:58347 (JUL-730-RW)
electrolysis of, determination of current efficiency by neutron activation and silver-110 tracers, 25:58360
fatigue properties of, calculations from model of Griffith cracks, 25:58209 (AECL-3992)
preparation of spheroidized powders of, using plasma heating, 25:58187(T) (SCL-T-710281)
Al_2O_3--$AlPO_4$, performance as protective coatings on metals exposed to high-temperature flowing gases, 25:58375
Al_2O_3--CoO, preparation for high-temperature neutron dosimetry, 25:57723 (CONF-711002-, pp 82-5)
Al_2O_3--polyethylene, radiation effects on mechanical properties and creep resistance of composites of, gamma, 25:58416(R) (RLO-2098-2)

ALUMINUM PHOSPHATES
Al_2O_3--$AlPO_4$, performance as protective coatings on metals exposed to high-temperature flowing gases, 25:58375
$AlPO_4$--ZrO_2, performance as protective coatings on metals exposed to high-temperature flowing gases, 25:58375

AMERICIUM
oxidation potential for trivalent--tetravalent, 25:57437
preparation of targets of, by vacuum evaporation, 25:59638 (CONF-711002-, pp 116-21)
preparation of thick samples of, by powder metallurgy, 25:58181 (CONF-711002-, pp 77-81)

XUM

  preparation of thin films of, by electrophoresis and electrospraying, 25:58183 (CONF-711002-, pp 160-5)
  separation from curium by electromigration, 25:57520 (JINR-E6-5952)
  separation from curium by ion exchange chromatography on zirconium phosphate, 25:57551
  separation from other actinides by paper or thin-layer chromatography, 25:57553
  spectra of hexavalent, in dilute sodium carbonate solutions, absorption, 25:57403
AMERICIUM ISOTOPES
  cross section measurements of, nondestructive and destructive methods of analysis used in fabrication of targets for, 25:57345 (CONF-711002-, pp 293-306)
AMERICIUM ISOTOPES Am-241
  decay scheme, 25:57998 (NIRS-Pu-8)
  determination in biological materials, alpha spectra unfolding method for, 25:57362
AMERICIUM ISOTOPES Am-243
  production by target irradiation in HFIR and processing in TRU, 25:57524 (ORNL-TM-3343)
AMERICIUM OXIDES
  preparation of thin-film radiation sources of, by radiofrequency sputtering, 25:57651 (CONF-711002-, pp 147-59)
  AmO$_2$--Cu, preparation of thin-film radiation sources of, radiofrequency sputtering method for, 25:57651 (CONF-711002-, pp 147-59)
  AmO$_2$--Cu, sputtering of cermets of, for preparation of thin-film americium oxide radiation sources, 25:57651 (CONF-711002-, pp 147-59)
AMERICIUM SULFATES
  complexes with cobalthexaammine ion, preparation and structure of, 25:57403
AMIDE POLYMERS
  reactions of nylon, with fluorine, 25:57619 (RFP-1739)
AMIDES
  radioinduced polymerization of, at low doses, 25:57451(P)
AMINO ACIDS
  formation in early solar system by catalytic synthesis, (E/T), 25:58576
  formation in early solar system by catalytic synthesis, (E/T), 25:58575
AMINOPTERIN
  effects on yeast cells, correlation of x radiosensitivity with, 25:57927
AMMETERS
  development of automatic-ranging pico-, for reactor control and protection, 25:57899
AMMONIA
  analysis of analytical grade, for impurities by neutron activation, 25:57379
  preparation of, radiation effects on catalytic activity of iron in, 25:57444
  radiolysis of solid layers of undeuterated and deuterated, ESR study of electron, 25:57470
  spectra in 0.5-mm wavelength region, effects of deuterium and nitrogen-15 on rotational, 25:57424
AMMONIUM BROMIDES
  hexane--NH$_4$Br, bromine-80m isomeric transition in, reactions of recoils from, 25:57494
AMMONIUM COMPOUNDS, SUBSTITUTED
  ammonium dioxovanadium(V) bisoxalate dihydrate, radiation effects on single crystals of, ESR studies on vanadyl ions produced by uv or x, 25:57449
  tetrakis(decyl)ammonium chloride, complexes with uranyl chloride, reactions with titanium chloride for reduction of uranyl ion, 25:57415
AMMONIUM RHENATES
  proton bombardment of, production of radioactive rhenium isotopes by, 25:57480 (JINR-P6-5955)
AMMONIUM URANYL NITRATES
  symmetry types of uniaxial and biaxial crystals of, 25:58703
AMPHIBIA
  Ambystoma tigrinum, radiation effects on ultrastructure of liver cells of, x, 25:58112
  Pleurodeles waltii, radiation effects on DNA and RNA synthesis in embryos of, effects of dose on x, 25:57944
  Triturus viridescens, radiation effects on participation of cells in limb regeneration, 25:58103
AMPLIFIERS
  circuits for satellite-borne low-power charge-sensitive FET, for proton spectrometry, 25:57821
  design and performance of charge-sensitive, for space applications of silicon detectors, 25:57792
  design for segmented ionization chamber, 25:57757(P)
  testing of charge-sensitive, circuits for programmable solid-state pulser for, 25:57896
ANGIOSPERMIDAE
  Astragalus sp., phosphorus-32 uptake by leaves and roots of, 25:57950
  Avena sativa, phosphorus-32 uptake by leaves and roots of, 25:57950
  Crepis capillaris, radioinduced chromosome aberrations in seed of, effects of time of onset of mitosis on frequency of fast neutron, γ, and x, 25:57968
  Fagopyrum sp., phosphorus-32 uptake by pure and mixed stands of, effects of season on, 25:57949
  Helianthus annuus, radiosensitivity of varieties of, seed exposure gamma, 25:58148
  Hordeum sp., radioinduced chlorophyll mutations in, protective effects of cysteine, thiourea, and urea against x, 25:57974
  Hordeum sp., radiosensitivity of chromosomes in seed of, grown at high altitudes, effects of uv-deficient light conditions on γ, 25:57969
  Lupinus sp., phosphorus-32 uptake by pure and mixed stands of, effects of season on, 25:57949
  Lupinus sp., radiation effects on germination and survival of pure and hybrid forms of, x, 25:58149
  Nicotiana xanthi, radiation effects on frequency of somatic recombinations in chlorophyll mutants of, γ, 25:57977
  Pisum sativum, radioinduced mutations in, following seed exposure, comparison of neutron and x, 25:57960
  Pisum sp., radiation effects on metabolism of amino acids and sugars in, gamma, 25:57931
  Pisum sp., radiation effects on phosphorus metabolism in, γ, 25:57941
  Quercus alba, radiation effects on density of leaf miners on shoots of, effects of dose on γ, 25:58092
  Quercus rubrum, radiation effects on microfungal populations in litter of, effects of dose on γ, 25:58150
  Triticum sp., radiation effects on female gametes and survival of, dose dependence of x, 25:58152
  Triticum sp., radiation effects on metabolism of amino acids and sugars in, gamma, 25:57931
  Triticum sp., radiation effects on phosphorus metabolism in, γ, 25:57941
  Zea sp., radiation effects on grain yield and uptake of nitrogen and phosphorus from fertilizers and soil by, γ, 25:58154
ANILINE
  vibration spectra of, pulsed neutron-scattering of, 25:58384
ANIMALS
  book: Protection of Animals Against Injury by Nuclear Weapons, 25:58026
  radiation effects on circulatory system of laboratory, pathology of, 25:58122
  tritium oxide toxic effects on species of, comparison of, 25:57916
  uranium distribution between skeletons of marine, and seawater, 25:57409
ANISOLE
  effects on γ-radioinduced polymerization of styrene in carbon tetrachloride or hexachlorobutadiene solutions, 25:57454
ANTHRACENE
  effects on γ-radioinduced polymerization of styrene in carbon tetrachloride or hexachlorobutadiene solutions, 25:57454
ANTIBIOTICS
  effects of hygromycin B, on frequency of x-radioinduced mutations in spores of Actinomyces hygroscopicus, 25:57964
ANTIBODIES
  detection of antinuclear, in mice, 25:60285 (RLO-2226-T-3-8)
  radioimmunoassay of virus, in blood serum, 25:57912
ANTIMONY
  analysis for oxygen by 14-MeV neutron activation and γ spectrometry, 25:57376
  neutron capture at 400 keV by natural, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801
ANTIMONY ALLOYS AND SYSTEMS
  Ga--Sb, radiation damage in GaSb, review of, 25:59138
  In--Sb, radiation damage in InSb, review of, 25:59138
ANTIMONY IONS
  implantation in silicon carbide at 40 keV, 25:59171
  ranges and stragglings in silicon at 20 to 400 keV, calculations of, 25:59116
ANTINEOPLASTIC DRUGS
  effects on normal tissues in man during supervoltage radiotherapy, 25:58077
ARGININE
  radiation effects on metabolism in pea and wheat plants and their offspring, gamma, 25:57931
ARGON
  argon-ion reactions with, energy spectra of electrons from, (T), 25:58733
  beta-particle reactions with, mean energy loss per ion pair formed in, (E), 25:59122
  electric discharges in alkali-metal-seeded, properties of high-current, 25:59023
  electron inelastic scattering at 10 keV, multiple ionization from, (E), 25:58754
  hydrogen-atom reactions with, effects of orbital momentum on formation of highly excited hydrogen atoms in, (T), 25:58734
  ionization in lunar atmosphere and associated properties, 25:58679
  oxygen-ion (O$^+$) reactions at 10 to 170 eV with, effects of excited states on charge exchange in, (E), 25:58763
  plasma jets of, electron density and temperature measurement using lasers, (E/T), 25:58987
  plasma jets of, interferometric determination of temperature in, (E), 25:58984

  plasma jets of, spectroscopic diagnostics of, 25:58991
  plasma of, in pseudo equilibrium with additions, interactions of, 25:59018
  positron annihilation in, time dependence of, (E), 25:58725
  proton reactions with, effects of orbital momentum on formation of highly excited hydrogen atoms in, (T), 25:58734
  reactions between atoms of, at 57 to 240 eV, energy spectra of ionization products from, (E), 25:58764
  solubility in sodium, 25:58387(R) (ANL-7823)
ARGON IONS
  effects on benzene vapor at 60 keV, yields from, 25:57469
  effects on germanium monocrystals at 10 to 30 keV, electron emission induced by, 25:59175
  effects on incidence of single- and double-strand breaks in phi X-174 replicative form of DNA, effects of LET on, 25:57952 (LBL-28)
  reactions with argon, energy spectra of electrons from, (T), 25:58733
  reactions with germanium crystals at 10 to 30 keV, angular dependence of, (E/T), 25:59146
ARGON ISOTOPES Ar-36
  energy levels of, calculation for α-hole, 25:59757
  production in stars from simple helium burning, (E), 25:58508
ARGON ISOTOPES Ar-40
  energy level at 2.13 MeV, lifetime for, (E), 25:59771
ARGON SYSTEMS
  Ar--H_2O, radiolysis of, charge exchange and transition reactions of hydrogen from electron, 25:57460
ARKANSAS
  fallout monitoring at Fayetteville, May 1966 to Jan. 1969, 25:57578
ARKANSAS NUCLEAR ONE POWER REACTOR, UNIT 2
  design parameters of, raised and additional data on, 25:59994 (DOCKET-50368-17)
  operations aspects of, revised and additional data on, 25:59994 (DOCKET-50368-17)
ARMY REACTORS (MH-1)
  physics calculations for MH-1A Core 2 and Core 3, 25:60203 (AD-721019)
ARMY REACTORS (PM-3)
  maintenance during 1970, 25:60206
  operation during 1970, 25:60206
ARSENIC
  determination in analytical reagents by neutron activation, 25:57379
  radioinduced production in germanium, effects on infrared absorption, 25:58343
  reactions with chromium and plutonium, 25:57413
ARSENIC IONS
  ranges and stragglings in silicon at 20 to 400 keV, calculations of, 25:59116
ARSENIC ISOTOPES AS-68
  beta and electron-capture decay of, branching ratios, gamma spectra, half-life, and log-ft value for, (E), 25:59747
ARSENIC ISOTOPES As-76
  beta decay of, gamma spectra, half-life, Kurie plots, and log-ft and Q values for, (E), 25:59748
ARSENIC ISOTOPES As-80
  beta decay of, branching ratios, gamma spectra, half-life, and log-ft values for, (E), 25:59749
ARSENIC SYSTEMS
  As--Ge--Te, radiation effects on crystal structure of glass-forming chalcogenide of, fast neutron, 25:58419
ASBESTOS
  reactions with fluorine, 25:57619 (RFP-1739)
ASPARTATE AMINOTRANSFERASE
  radiation effects on activity in mitochondria of brain, liver, and heart of adrenalectomized rats, x, 25:57933
ASTEROIDS
  capture by Jupiter, Deser--Laurent theory of gravitation for mechanism for, (T), 25:59585
ASTRONAUTS
  radiation dose to USSR Soyuz-9, preflight calculations of, 25:58006
  radiation hazards to, during prolonged duty on space stations, effects of shielding during solar flares on, 25:58025(T) (ORNL-tr-2490)
ASTRONOMY
  research projects conducted by Centre National d'Etudes Spatiales, Paris, 25:58444
ASTROPHYSICS
  conference on statistical thermodynamics in, Cardiff, Wales, 4/70, 25:58670
ATLANTIC OCEAN
  strontium-89 and strontium-90 deposition in, during 1970, 25:57981(R) (HASL-245(App.))
ATMOSPHERE
  book: Studies of Atmosphere and Ionosphere at Times of Unusual Solar Activity, (E), 25:58893
  cesium-137 content of Japanese, 1963 to 1971, 25:57579
  fallout monitoring during 1970, 25:57980(R) (HASL-245)
  fallout monitoring in Swedish, following 10th Chinese nuclear explosion, 25:57580
  fallout monitoring of Fayetteville, Arkansas, May 1966 to Jan. 1969, 25:57578
  fallout monitoring of Swedish, following Dec. 27, 1968 Chinese nuclear explosion, 25:57577
  particle penetration in, two-, three-, and four-group parallel, (E/T), 25:58828
  particle ratios at altitudes of 800 gm/cm^2 in, pion-to-proton and neutral-to-charged, (E), 25:58834
  pressure measurements in, for estimating nuclear explosion energy yield, 25:57606
  radio-noise bursts at 3 MHz from lightning-flash radiation, pulse characteristics of, (E), 25:58876
  radioactivity monitoring in, conference on, Obninsk, July 30 to Aug. 2, 1968, 25:57576
  radioactivity of off-site, following Schooner Event, monitoring of, 25:57574 (PNE-524)
  radioactivity of surface, in Central, North, and South America during March 1971, gross β, 25:57992
  radioactivity of surface, of Central, North, and South America during April 1971, gross β, 25:57984
  radioactivity of the Netherlands, during 1967, gross α, β, γ, 25:57575 (RA-42)
  radioisotope content of, over Central, North, and South America during 1970, 25:57981(R) (HASL-245(App.))
  strontium-90 content of Japanese, 1963 to 1971, 25:57579
  trough development at solar-activity maximum and minimum, relation with geomagnetic storms, (E), 25:58860
  tungsten-187 content of off-site, following Schooner Event, (E), 25:57574 (PNE-524)
  x-radiation spectra and flux in deep, effects of atmospheric scattering and absorption on auroral, (E), 25:58868
ATMOSPHERE EXPOSURE CHAMBERS
  development for plutonium aerosol inhalation studies on rats, 25:57998 (NIRS-Pu-8)
ATMOSPHERIC PRECIPITATION
  fallout monitoring during 1970, 25:57980(R) (HASL-245)
  radioactivity in Central, North, and South America during April 1971, gross β, 25:57984
  radioactivity in Central, North, and South America during March 1971, gross β, 25:57992
ATOMIC BEAMS
  injection into high-temperature plasma, penetration of, (T), 25:59030
  production of highly excited, review of methods for, 25:58691
ATOMIC ENERGY COMMISSION (USA)
  nuclear power development by, role of contractors in, 25:60017
ATOMIC ENERGY, LEGAL ASPECTS
  book: World Use of Atomic Energy. Questions of International Law, in Russian, 25:60296
  legislation on use of accelerator-produced radioisotopes and radium in industry and medicine in USA, Federal and State, 25:58028 (BRH/DMRE-71-4)
ATOMIC MODELS
  Hartree--Fock F/sup k/ integrals for, comparison with experiment, 25:58797
  performance for photoionization cross sections, evaluation of, 25:58684
  statistical, based on local Coulomb approximation, 25:58815
ATOMIC PHYSICS
  book: Topics in Modern Physics: A Tribute to Edward U. Condon, 25:58682
ATOMIC STRUCTURE
  angular momentum operators in j--j coupling, eigenfunctions for, 25:58801
  conference on theory of, Gif-sur-Yvette, France, 7/70, 25:58783
  electron correlation in, ways of introduction of, 25:58793
  energy level configuration interactions in, effective operators for, 25:58798
  group theory for (d+s)/sup n/p/sup m/ configurations, SU_3, 25:58787
  group theory for many-electron, possibility of noncompact, 25:58788
  group theory for radial wave functions, O(2,1), 25:58786
  group theory for, second use of G_2, 25:58785
  Hamiltonian for many-electron atoms, relativistic, 25:58799
  Hamiltonian function for, spatial eigenfunctions of spin-independent many-electron, 25:58791
  many-body problem solutions for pseudo-atoms, 25:58796
  S functions and symmetry principles for, 25:58790
  symmetrics in, stability of self-consistent, 25:58792
  symmetry relations for, reflection, 25:58784
  theory of, variational potentials and Lagrangian multipliers in pseudopotential, 25:58814
  wave function representation and reduced matrix elements for, 25:58789
  wave functions for open-shell, relativistic, 25:58800
ATOMS
  electron correlation functions for nonclosed-shell many-electron, structure and symmetry properties of, 25:58806
  electron fractional occupational numbers and transition probabilities in, statistical exchange in calculation of, 25:58718
  electron interactions in, evaluation of one-center repulsion integrals for, 25:58808
  electron reactions with closed-shell, construction of model potentials for, 25:58772
  electron reactions with, approximate analytical

  expressions and scaling relations for excitation and ionization cross sections for, 25:58740
  electron reactions with, review of energy resolution in, 25:58747
  electron reactions with, review of threshold laws for excitation and ionization in, 25:58745
  electron reactions with, semi-empirical formula for ionization cross sections for, 25:58738
  electron scattering at 10 to 100 keV by Z = 1 through 57 and 72 through 90, factors for, 25:58748
  electron scattering by, compound states in, (T), 25:58804
  electron screening in, correlation of constants for K-level, (T), 25:58817
  energy level transitions in, strong correlation between Cherenkov effect and properties of photon tachyons in disappearing Fresnel wave for dipole, (T), 25:59573
  energy level transitions of, probabilities for relativistic radiative bound--bound, 25:58816
  energy of free, containing one or two open shells, computer program for, 25:58709
  energy of ground-state two-electron, calculation using perturbation theory, 25:58818
  energy of many-electron, formula for relativistic, 25:58819
  energy-level transition probabilities and fractional occupation numbers in, statistical exchange in calculation of, 25:58718
  energy-level transitions of one- and two-electron, magnetic-dipole operator for calculation of, 25:58803
  hydrogen-atom reactions with, effects of orbital momentum on formation of highly excited hydrogen atoms in, (T), 25:58734
  interactions between excited and ground-state, frequency distribution of radiation emitted from, (T), 25:58807
  interactions between ground-state, linear-response theory including exchange for, 25:58809
  interactions in system of, many body theory for composite, 25:59232
  ion reactions in keV range with, effects of velocity and outer-shell configuration on production of K vacancies in, (E), 25:58756
  ion reactions with P-state, depolarization in, (T), 25:58746
  ion reactions with, energy spectra of electrons from, (T), 25:58733
  ion reactions with, merging-beams method for study of, 25:58744
  ion reactions with, review of charge exchange in, (E), 25:58743
  ionization in electric fields, review, 25:58691
  ionization of, many-body theory of auto-, 25:58802
  ionization potentials of, containing one to ten electrons, review of, 25:58715
  Lamb shift of, calculation for all atomic numbers, 25:58813
  photoionization cross sections for, atomic models for, 25:58684
  plasma oscillations in, existence and damping of, (T), 25:58820
  properties of highly excited, review, 25:58691
  properties of hydrogenic, use of factorization method and group theory in relativistic treatment of, 25:58821
  properties of, upper and lower bounds to expectation values for, (T), 25:58810
  proton reactions with, approximate analytical expressions and scaling relations for excitation and ionization cross sections for, 25:58740
  proton reactions with, effects of orbital momentum on formation of highly excited hydrogen atoms in, (T), 25:58734
  radiation emission from systems of N two-level, intensity of cooperative spontaneous, (T), 25:58812
  reactions between excited and ground-state, depolarization and excitation transfer in, (T), 25:58746
  reactions with diatomic molecules, adiabatic-approximation calculations of vibrational transition probabilities in, 25:58761
  reactions with diatomic molecules, reaction matrix method for calculation of transition probabilities in, 25:58762
  reactions with hot solid surfaces, harmonic-model analysis of, 25:58690
  reactions with molecules at thermal energies of highly excited, cross sections for ionization in, (T), 25:58750
  reactions with molecules with formation of long-lived complexes, angular distribution of products from, (T), 25:58773
  reactions with Morse oscillators, semiclassical treatment of collinear, 25:58727
  reactions with solid surfaces, review of Auger and resonance processes in, (E/T), 25:58692
  scattering at high energies, anomaly in differential cross sections for, (T), 25:58767
  spectra in magnetic fields, theory of quadratic Zeeman effect for, 25:58696
  spectra of, polynomial identity for vector operators for Lie algebra of SO(n) for quantum theory of, (T), 25:59538
  spectral hyperfine effects in, many-body theory for, 25:58794
  spin--orbit coupling in, Z dependence of, 25:58716
  theory of, with magnetic charges as models of hadrons, 25:59447
AURORAE
  electron energy spectra in, equipment for measuring, 25:57790
  mechanism of break-up of, relation to electric coupling between magnetosphere and ionosphere, (E/T), 25:58909
  occurrence of visual, relation to electrojet-current intensity in auroral boundaries, (E), 25:58857
  plasma instabilities in magnetospheric, review of, 25:58895
  proton energy spectra in, equipment for measuring, 25:57790
  pulsations of, correlation with cosmic radio-noise absorption, 1964--1968, (E/T), 25:58858
  spectral emission in, spectrophotometric data from Jan.-Mar., 1968 and Nov.-Dec., 1969, (E), 25:58883
  x-radiation penetration through atmosphere, effects of atmospheric scattering and absorption on, (E), 25:58868
AURORAL ZONE
  disturbances of, effects of unstable radiation zone on, (E/T), 25:58906
  particle precipitation patterns in high-latitude, energetic electron, proton, and helium-ion, 25:58896
  proton intensity in morning sector of, during slowly varying cosmic-noise absorption, (E), 25:58891
  pulsation time lag of cosmic-noise absorption in, behind simultaneous x-ray pulsations, luminosity, and micropulsations, (E/T), 25:58863
AUSTRALIA
  nuclear power development during July 1970 to June 1971, 25:60276(R) (NP-19036)
  nuclear power plant economics in, 25:59919
AUTORADIOGRAPHY
  method for high-speed measurement of alpha activity from polonium-210 or plutonium-239 on air filters, 25:57998 (NIRS-Pu-8)
  method for hot cell, of irradiated fast reactor fuel elements, 25:57693
  method for whole-body measurement of plutonium-239 distribution in mice and rats, 25:57998 (NIRS-Pu-8)
  performance for detection of carbon-14-labeled compounds, 25:57752
AVES
  Columba sp., radiation effects on chemical properties and ultrastructure of in vitro erythrocytes of, uv, 25:58113
  Gallus sp., immunization against Ascaridia using γ irradiated eggs, 25:57946
  Gallus sp., radioinduced formation of immunoglobulin-like proteins in bursectomized, x, 25:57934
1-AZIRIDINECARBOXAMIDE, N,N'-HEXAMETHYLENEBIS-
  effects on oogenesis and reproductive system of beet leafhoppers following exposure of adults and nymphs, 25:58093

B

BACTERIOPHAGES
  lambda, induction of prophage of, in Escherichia coli through conjugal transfer of uv-damaged F-prime sex factors, 25:57956
  N1, radiation effects on, protective effects of versene against γ and uv, 25:58032
  phi X 174, radiation effects on, protective effects of versene against γ and uv, 25:58032
  phi X 174, radioinduced mutations in, effects of oxygen, nitrogen, and thiourea on γ and x, 25:57971
  s/sub d/, radiation effects on, protective effects of versene against γ and uv, 25:58032
  T2, radiation effects on, protective effects of versene against γ and uv, 25:58032
BALANCES
  use in assay of materials used in nuclear measurements, 25:59640 (CONF-711002-, pp 272-82)
BARIUM
  content of foods in Kiev region of Soviet Union, 25:57987
  determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
  electron reactions up to 1 keV with, total cross sections for ionization in, (E), 25:58777
  precipitation with bone mineral analog calcium hydroxylapatite by isomorphous cocrystallization, 25:57418
  separation from calcium by solvent extraction, 25:57304
  thermal emission properties on tantalum, 25:59177
BARIUM CERATES
  formation and phase behavior in barium oxide--cerium oxide system, 25:58405
BARIUM FLUORIDES
  performance and physical properties for charged-particle and gamma-ray detection, scintillation, 25:57817
BARIUM IONS
  spectra in solar granules, (E), 25:58594

XUM

BARIUM ISOTOPES Ba-133
- use as tracer to study losses from oxide coatings on lamp cathodes, 25:57660

BARIUM ISOTOPES Ba-137
- production of metastable, from cesium-137 generator using fixing agent, method for, 25:57484(P)

BARIUM ISOTOPES Ba-138
- electron scattering at 200 and 500 MeV, differential cross sections for, (E), 25:59793
- nuclear charge distribution from electron differential scattering cross sections at 200 and 500 MeV and least-squares analysis, (E/T), 25:59793

BARIUM ISOTOPES Ba-140
- determination in reactor effluent water by ion exchange and γ spectroscopy or radiochemical methods, 25:57351
- distribution in skin tissues following cutaneous application, 25:57917

BARIUM OXIDES
- BaO--CeO$_2$, phase equilibria in, 25:58405

BARNWELL NUCLEAR FUEL PROCESSING PLANT
- construction of, evaluation of suspension of permit for, 25:57516 (DOCKET-50332-20)
- environmental studies for, 25:57516 (DOCKET-50332-20)

BARYONS
- decay baryons $\to$ baryons + π, current algebra sum rules in Glashow model for CP-violating amplitudes of, 25:59408
- form factors of, O(4,2) x SU(3) symmetry for electromagnetic, (T), 25:59548
- interactions in ultradense matter, (T), 25:58432
- interactions with antibaryons in quark model, failure of duality in, 25:59467
- interactions with baryons and mesons in nonchiral U(6) x U(6), duality diagrams and representation mixing for, 25:59549
- interactions with mesons and baryons at high energies, relation of coherent state method with quark models for, (T), 25:59448 (JINR-E2-6025)
- interactions with mesons, consistency conditions between SU(3) and exchange degeneracy in, 25:59493
- interactions with mesons, polarization predictions from double-Regge-pole exchange for, 25:59503
- interactions with pseudoscalar mesons, spin amplitudes for pseudoscalar meson and 1/2$^+$ baryon production in, (T), 25:59471 (CEA-N-1456)
- mass differences of octet, Nambu--Goldstone chiral symmetry breaking for electromagnetic, (T), 25:59541
- mass of, O(4,2) x SU(3) symmetry for, (T), 25:59548
- mass shifts of octet, linear SU(3) sigma model for correlation between eta $\to 3\pi$ decay, K mass shift, and $\Delta I = 1$, 25:59380

BARYONS (ANTIPARTICLES)
- interactions with baryons in quark model, failure of duality in, 25:59467

BARYONS, RESONANCE
- decay rates of, SU(3) predictions for, 25:59491
- existence of ($\Delta\Delta N$) $A > 4$, probability for, 25:59521
- production of $S_{11}(1525)$ in $\pi + N$ interactions, dispersion theoretic model for, 25:59486
- theory for, Regge trajectory with finite asymptotic phase in, (T), 25:59451

BARYONS, RESONANCE (N*)
- decay of N*(1500), spin--parity analysis from, 25:59307
- decay of N*(1700), spin--parity analysis from, 25:59307
- effects of $\Delta(1236)$ - $\Delta(1236)$ admixtures on deuteron form factors for $e + d \to e + d$ interactions, (T), 25:59367
- existence and properties of quasinuclear 2NantiN(2090), 2NantiN(2540), 2NantiN(2740), 2NantiN(2800), potential approach for, (T), 25:59500
- mass and width of Δ^{++} in five- and six-charged-particle final states in $\pi^+ + d$ interactions at 2.7 and 3.1 GeV/c in bubble chamber, (E), 25:59282
- mass and width of $\Delta^{--}(1236)$, $\Delta^{++}(1236)$, $N\pi\pi(1460)$, and $N\pi\pi(1712)$ in anti $p + p \to$ anti $p + p + \pi^+ + \pi^-$ interactions at 7 GeV/c, (E), 25:59267
- production in $e + N$ interactions and lepton interactions with nucleons, relativistic model for inelastic form factors, widths, and locations for, (T), 25:59337
- production of Δ^{++} in five- and six-charged-particle final states in $\pi^+ + d$ interactions at 2.7 and 3.1 GeV/c in bubble chamber, (E), 25:59282
- production of $\Delta^{--}(1236)$, $\Delta^{++}(1236)$, $N\pi\pi(1460)$, and $N\pi\pi(1712)$ in anti $p + p \to$ anti $p + p + \pi^+ + \pi^-$ interactions at 7 GeV/c, (E), 25:59267
- production of N*(1500) and N*(1700) in $\pi^+ + d \to$ p/sub s/ $+ p + \pi^+ + \pi^- + \pi^0$ at 7.0 GeV/c, diffraction dissociation mechanism for, 25:59307
- production of N*(1500) and N*(1700) in $\pi^- + p \to \pi^- + \pi^- + \pi^+ + p$ interactions at 7 and 25 GeV/c, diffraction dissociation mechanism for, 25:59307
- production of N*(1700) in $\pi + N \to \pi + \Lambda + K$ interactions at 7 GeV/c, 25:59307
- production of $n\pi^+\pi^-(1450)$ and $p\pi^+\pi^-(1450)$ enhancements in $K^- + d \to K^- + \pi^+ + \pi^- + n + p$ interactions at 12.6 GeV/c, (E), 25:59283
- production of $p\pi^-(1450)$ enhancement in $K^- + d \to K^- + \pi^- + 2p$ interactions at 12.6 GeV/c, (E), 25:59283
- production of $S_{11}(1530)$ in $\gamma + d \to$ eta $+ d$ interactions, amplitudes with anomalous thresholds for, (T), 25:59514
- production of $S_{11}(1530)$ in $\gamma + p \to$ eta $+ p$ interactions below 1 GeV/c, (T), 25:59514
- production of $\Sigma^-(1385)$ simultaneously with vector mesons in Λ and Σ^0 four-body final states in $K^- + n$ interactions at 4.48 GeV/c in deuterium bubble chamber, spin-density matrix elements for, (E), 25:59280
- reactions of Δ isobar with $A > 4$ nuclei, probability for multibaryon resonances from, 25:59521
- widths in $e + N$ and lepton interactions with nucleons, relativistic model for, (T), 25:59337

BARYONS, RESONANCE (Y*)
- decay of $\Sigma(1640)$ in deuterium bubble chamber, branching ratios for, (E), 25:59280
- decay $\Sigma^+(1385) \to \Sigma(\Lambda) + \pi$ in hydrogen bubble chamber, rate for, (E), 25:59284
- decay $\Sigma^+(1670) \to \Sigma^0 + \pi^+$ in hydrogen bubble chamber, rate for, (E), 25:59284
- decay $\Sigma^+(1915) \to \Sigma^0 + \pi^+$ in hydrogen bubble chamber, rate for, (E), 25:59284
- decay $\Sigma^+(2250) \to \Sigma^0 + \pi^+$ in hydrogen bubble chamber, rate for, (E), 25:59284
- mass and width of $\Sigma(1910)$ and $\Sigma(2030)$ from $K^- + N \to \Lambda + \pi$ interactions at 1 to 1.85 GeV/c, (E), 25:59303
- mass and width of $\Sigma^+(1385)$ and $\Sigma^+(1670)$ in $K^- + p \to \Lambda + \pi^+ + \pi^-$ interactions at 3.9 to 5.0 GeV/c in hydrogen bubble chamber, (E), 25:59284
- mass and width of $\Sigma^+(1385)$, $\Sigma^+(1670)$, $\Sigma^+(1915)$, and $\Sigma^+(2250)$ in $K^- + p \to \Sigma^0 + \pi^+ + \pi^-$ interactions at 3.9 to 5.0 GeV/c in hydrogen bubble chamber, (E), 25:59284
- production of Σ^* in $K^- + p \to p + \pi^-$ + anti K^0 interactions at 3.9 to 5.0 GeV/c in hydrogen bubble chamber, (E), 25:59284
- production of $\Sigma(1640)$ in Λ four-body final states in $K^- + n$ interactions at 4.48 GeV/c in deuterium bubble chamber, mechanism for, (E), 25:59280
- production of $\Sigma^+(1385)$ and $\Sigma^+(1670)$ in $K^- + p \to \Lambda + \pi^+ + \pi^-$ interactions at 3.9 to 5.0 GeV/c in hydrogen bubble chamber, (E), 25:59284
- production of $\Sigma^+(1385)$, $\Sigma^+(1670)$, $\Sigma^+(1915)$, and $\Sigma^+(2250)$ in $K^- + p \to \Sigma^0 + \pi^+ + \pi^-$ interactions at 3.9 to 5.0 GeV/c in hydrogen bubble chamber, (E), 25:59284

BEAM SEPARATORS
- operation of dc electrostatic, international survey on, 25:59644 (RHEL/R-222)

BEARINGS
- design and performance of ball, for SNAP-8 turboalternator and pump, 25:57617 (N-71-26910)
- design of lubricant-immersed, for vertical-axis rotors, 25:57634(P)

BEAVER VALLEY POWER REACTOR, UNIT 1
- construction of, request for not suspending permit for, 25:59982 (DOCKET-50334-26)

BEHAVIOR
- radiation effects on operant, of rats following intraperitoneal injection of iodine-131 during gestation, 25:58100

BENZ[a]ANTHRACENE, 7,12-DIMETHYL-
- effects on mice, effects of deuterium on carcinogenic, 25:57920

BENZENE
- effects on chemical state of recoil phosphorus-32 from neutron-irradiated tripolyphosphate hexahydrate, 25:57495
- radioinduced polymerization of, effects of recoil atoms of carbon-14 produced from incorporated aluminum nitride on neutron, 25:57456
- radiolysis of vapor-phase, by argon, krypton, lead, neon, and xenon ions at 60 keV, effects of ion mass on yields from, 25:57469

BENZENE, DIVINYL-
- poly(divinylbenzene)--polystyrene, properties as carrier of stationary phase in chromatographic separations, 25:57527 (UJV-2557-Ch)

BENZOIC ACID, p-HYDROXY-
- complexes with phenylacetic acid and uranyl ions, stability of, 25:57402

BENZOIC ACID, VINYL ESTER
- reactions with solvated electrons, rate constant of, 25:57475

BERKELIUM
- oxidation potential for trivalent--tetravalent, 25:57437
- separation from other transplutonium elements and fission products by sorption on zirconium phosphate--silicate, 25:57530

BERKELIUM ISOTOPES Bk-249
- production by target irradiation in HFIR and processing in TRU, 25:57524 (ORNL-TM-3343)

BERYLLIUM
- analysis for carbon and oxygen by γ activation, nondestructive, 25:57385
- deformation of crystals of, x-ray synergy method for study of defects in compressive, 25:58263
- effects on complexonometric determination of rare earths, 25:57317
- effects on periodic precipitation in silver--cadmium alloys, 25:58262
- fabrication of small-diameter wires of, development of method for, 25:58199
- photon reactions (γ,α) with, pulse-height spectra from, (E), 25:59734

BERYLLIUM ALLOYS AND SYSTEMS
- Be--Cu-base, oxidation at high temperatures, mechanisms of, 25:58171

- BERYLLIUM FLUORIDES
  - spectra in molten fluorides, Raman, 25:57298 (ORNL-4676, pp 73-138)
  - BeF$_2$--LiF, solvent properties of molten, for gaseous boron trifluoride, 25:57298 (ORNL-4676, pp 73-138)
  - BeF$_2$--LiF, thermodynamic properties of molten, 25:57298 (ORNL-4676, pp 73-138)
  - BeF$_2$--LiF--ThF$_4$, separation of cesium and rubidium from, by reductive extraction, 25:57298 (ORNL-4676, pp 73-138)
  - BeF$_2$--LiF--ThF$_4$--UF$_4$, heat transfer and thermophysical properties of, (E/T), 25:60015 (CRNL-4676, pp 21-72)
  - BeF$_2$--NaF, electric conductivity of molten and supercooled, 25:57298 (CRNL-4676, pp 73-138)
  - BeF$_2$--NaF, phase transitions in molten, 25:57298 (ORNL-4676, pp 73-138)
- BERYLLIUM IONS
  - reactions with celluloid films of multiply charged, film-thickness dependence of cross sections for electron capture and loss in, (E), 25:58695
  - wave functions for excited two-electron, Hulthen transform functions in approximation of, 25:58713
- BERYLLIUM ISOTOPES
  - abundance in primary cosmic radiation, (E), 25:58833
  - distribution in cosmic rays, effect of interstellar helium on, 25:59733
- BERYLLIUM ISOTOPES Be-7
  - energy levels from lithium-7 (He-3,t) reactions, widths for, (E), 25:59731
- BERYLLIUM ISOTOPES Be-8
  - energy levels from lithium-7 (He-3,d) reactions, widths for, (E), 25:59731
- BERYLLIUM ISOTOPES Be-9
  - deuteron reactions (d,α) at 0.9 to 2.2 MeV, differential cross sections and excitation functions for, (E), 25:59721
  - deuteron reactions (d,α) at 120 to 200 keV, energy levels of boron-11 from, (E), 25:59827 (CEA-R-4070)
  - deuteron reactions (d,p) and (d,t) at 120 to 200 keV, angular distributions and mechanisms for, (E/T), 25:59827 (CEA-R-4070)
  - deuteron reactions (d,p) at 2 to 10 MeV, distorted-wave analysis of proton polarization in, (T), 25:59722
  - energy-level transitions in π-mesic atoms of, cascade processes and x-ray emission in, (T), 25:58724
  - meson reactions (π^+,p) at 70 MeV, excitation energy spectra and upper limits for cross sections for, (E), 25:59710 (LA-DC-12781)
  - proton inelastic scattering with subsequent breakup, analysis of n-^{8}Be final-state interaction using effective-range approximation, (T), 25:59735
  - proton reactions (p,He-4), mechanisms for differential cross sections and angular distributions for, (E), 25:59711 (UCLA-10-P-18-32)
- BERYLLIUM ISOTOPES Be-12
  - energy level at 0.81 MeV from lithium-7 (Li-7,2p) reactions, (E), 25:59716
  - mass excess from lithium-7 (Li-7,2p) reactions, (E), 25:59716
- BERYLLIUM OXIDES
  - electron band structure from x-ray spectra, (E/T), 25:59178
  - ion transport numbers for, at 900 to 1180°C under low oxygen potentials, effects of ion radius on, 25:58379
- BERYLLIUM SULFATES
  - effects on nitrification by Nitrobacter agilis in soil suspension, 25:57401
- BETA DECAY
  - asymmetry in mirror Gamow--Teller, binding-energy effects on ft, (T), 25:59852
  - theory for nuclei far from stability line, (T), 25:59836 (KURRI-TR-76, pp 3-6)
  - theory for, elementary particle treatment in, (T), 25:59397
  - theory of first-forbidden, gross, (T), 25:59868
- BETA PARTICLES
  - detection and measurement of low-energy, in biological materials, performance of semiconductor detectors for, 25:58064
  - dosimetry of, intercomparison of survey detectors for, 25:57782
  - dosimetry of, lithium fluoride--Teflon dosimeters for surface, 25:57837
  - effects from incorporated yttrium-90 on catalytic activity of iron in ammonia synthesis, 25:57444
  - effects on chromosomes of Chaetomorpha, effects of dose on aberrant, 25:58153
  - effects on germanium monocrystals in magnetic field, electric potential induced in, 25:59143
  - effects on mammalian cells following administration of tritium-labeled thymidine, 25:58086
  - reactions with alkane vapors and argon, mean energy loss per ion pair formed in, (E), 25:59122
  - reactions with mercury vapor, mean energy for formation of ion pairs in, (E), 25:59123
  - scattering by materials used in nuclear measurements, material assay by, 25:59640 (CONF-711002-, pp 272-82)
- BETA SOURCES
  - determination in mixtures with other β emitters by liquid scintillation counting, 25:57353
  - determination in urine, methods used at CNEN for, 25:57347 (RT/PROT-(71)9)
  - distribution of low-energy, surface-barrier detector for measuring planar, 25:57769
  - separation from radioactive sewage by coagulation with ferric hydroxide, 25:57556
  - x radiation excitation in solids by, diffusion studies from, 25:57673
- BETA SPECTROMETERS
  - design and performance of low-background lithium-drifted germanium, for measurement of germanium-76 double beta decay, 25:57803
  - magnetic fields in, design of mutation NMR stabilizer for, 25:57824
- BETAINE
  - betaine--sucrose, use as release agent for evaporative production of carbon thin films, 25:58346 (CONF-711002-, pp 144-6)
- BETATRONS
  - description of B5M-25, for bremsstrahlung therapy, 25:59651
  - use in radiographic inspection of thick castings and welds, 25:57678 (INR-1204)
- BEVERAGES
  - wines, radiation processing effects on microflora in, additive effects of ultrasound on uv, 25:58158
- BIBLIOGRAPHIES
  - book: Isotopes: Bibliographies and Reference Tables. Volume III, 25:59697
  - on civil, industrial, and scientific uses for nuclear explosions, 25:57603 (TID-3522(Rev.9))
  - on industrial facilities and processes for heavy water production, 25:57652 (DAISE-70-8)
  - on nuclear science and technology: section 14 activation analysis, 25:57368 (AED-C-14-5)
  - on plasma physics and fusion reactors, 25:58955
  - on prestressed concrete pressure vessels for reactors, 25:57609 (AED-C-1-18)
- BIG ROCK POINT POWER REACTOR
  - technical specifications for, 25:59938 (DOCKET-50155-93)
- BIOLOGICAL MATERIALS
  - analysis for α, β, and γ emitters, methods used at CNEN, 25:57347 (RT/PROT-(71)9)
  - analysis for carbon-14, radiometric, 25:57364
  - analysis for cesium-137 by radiochemical isolation and γ spectrometry or beta detection, 25:57355
  - analysis for contaminants by heavy ion scattering, 25:57359
  - analysis for iodine-131 by isotopic exchange and scintillation counting, 25:57367
  - analysis for plutonium, radiochemical method for, 25:57998 (NIRS-Pu-8)
  - analysis for tin by neutron activation and rapid radiochemical separation, 25:57378
  - analysis for trace amounts of alpha sources, spectra unfolding method for, 25:57362
- BIOLOGICAL MODELS
  - development for gene loci in Drosophila chromosomes, 25:57975
  - use in studies of radioisotope transport kinetics in ecosystems, 25:57947 (CONF-710501-35)
- BIOMETRY
  - formulas for calculation of radioisotope excretion and retention time in man following acute or chronic intake, 25:57919
- BISMUTH
  - compatibility with brazing alloys at high temperatures, test program on, 25:58168 (ORNL-4676, pp 139-233)
  - determination by extraction using quinolinol melt and spectrography, 25:57312
  - determination in pure rare earth oxides, polarographic, 25:57311
  - diffusion in copper, beta-excited x-ray studies of, 25:57673
  - diffusion of trace amounts of thallium in molten, thermal, 25:58267
  - solubility in sodium at high temperatures, 25:58163(R) (AI-AEC-12859)
- BISMUTH ALLOYS AND SYSTEMS
  - Bi--In, density, diffusivity, and viscosity of, at 110 to 220°C, 25:58238
  - Bi--Li, solvent properties for neodymium and thorium, 25:57522 (ORNL-4676, pp 234-71)
  - Bi--Te, hardness of, 25:58253
  - Bi--U, magnetic transition temperature of U$_3$Bi$_4$, 25:59190
- BISMUTH ISOTOPES Bi-209
  - photofission at 0.1 to 5 GeV, giant resonance in yields and integral cross sections for, (E), 25:59794
  - photofission at 1000 MeV, mass yields from, (E), 25:59816
- BISMUTH ISOTOPES Bi-214
  - content in particles in French uranium mine air, (E), 25:57564
  - determination in presence of lead-214 and radium-226 by gamma spectrometry, 25:57365
- BLACK HOLES
  - existence in eclipsing binary beta Lyrae, (E/T), 25:58497
  - magnetic fields in, upper limits for, (T), 25:58498
- BLADDER
  - radiation effects on human, during therapy of gynecological neoplasms, effects of dose on cobalt-60

  contact γ, 25:58010
BLOOD
  circulation in human brain, use of xenon-133 scintigraphy for measurement of, 25:58058
  circulation studies using radioisotopes, intravenous semiconductor detector for, 25:57760(P)
  radiation effects on lymphocytes of, from chronic lymphocytic leukemia patients following extracorporeal exposure, γ, 25:58131 (CEA-CONF-1768)
  scintiscanning in mice, effects of pH on distribution of metastable indium-113 during, 25:58043
BLOOD PLASMA
  radioimmunoassay of epinephrine and norepinephrine in, double isotope method for, 25:57914
  radioimmunoassay of growth hormone in dog, 25:57909
  radioinduced quenching effect in, effectiveness as biological dosimeter in whole-body exposure, 25:58017
BLOOD SERUM
  radiation effects on lactate dehydrogenase activity in, of cervical cancer patients, effects of dose on γ, 25:57937
  radioimmunoassay of antibodies to virus antigens in, 25:57912
BLOOD VESSELS
  radiation effects on human, following therapy for thoracic diseases, 25:58147
  radiation injuries to laboratory animal, pathology of, 25:58122
BLUE STELLAR OBJECTS
  detection of galaxy associated, (E), 25:58539
BODY FLUIDS
  content in patients with renal hypertension, radioisotope dilution studies on, 25:57924
BOILERS
  design characteristics of superheating reactor core vessel, 25:60147(P)
  design of compact, for pressurized water reactors, 25:60144(P)
  design problems with fast reactor liquid sodium heated, 25:60077
  leak detection in sodium heated, design of hydrogen meter for, 25:60058(R) (ANL-7817)
  leaks in sodium-heated, evaluation of systems for detecting, 25:57632
  magnetite coatings in, relations of magnetite morphology with pressure drop, 25:58165(T) (AEC-tr-7237)
  performance of once-through NaK heated mercury, 25:60194 (N-71-27855)
  steam quality in power, rhenium-186 tracer method for measuring, 25:57674
  stress analysis of power reactor, finite element method for, 25:60142
BOILING
  heat transfer for film and transient, of subcooled water during free convection quenching of moving spheres, (E), 25:57642
BOLOMETERS
  development of nonisothermal superconducting, 25:58952
BOLTS AND NUTS
  failure of threaded, at nuclear facilities, data review on corrosion, fatigue, and galling, 25:57618 (ORNL-TM-3570)
BONDING
  methods for diffusion, review on, 25:58207
BONE MARROW
  effects of transplants of, on phosphorus-32 uptake by bone marrow, liver, and spleen of x-irradiated rats, 25:58123
  effects of transplants of, on recovery of x-irradiated mouse thymus, 25:58115
  effects on hematopoiesis following transplantation into spleen of irradiated mice, 25:58117
  radiation effects on mitosis in laboratory and wild rat, comparison of x, 25:58116
  radioprotective effects of extracts of, on survival of mice and rabbits, x, 25:58033
  scintigraphy using metastable technetium-99 colloids, 25:58053
  shielding of mouse, hematopoietic recovery following x irradiation with partial, 25:58124
  transplantation of osteogenic precursor cells of, to lethally irradiated hybrid mice, effects of hematopoietic cells on, 25:58121
BONES
  californium-252 distribution in rat, following intraperitoneal injection, 25:57922
  radiation effects on fluorine-18 uptake by fractured, 25:58105
  radiation effects on rat tibia, comparison of effects of dose on γ and x, 25:58102
  radiation effects on reimplantation of human mandibular, following surgical resection, x, 25:58132
BORON
  determination in glass by activation and prompt γ ray measurement, 25:57369(T) (RFP-Trans-83)
  preparation of standard thin-film layers of, by vacuum evaporation, 25:58182 (CONF-711002-, pp 122-33)
  radioinduced helium production in, measurement of in-pile, 25:58163(R) (AI-AEC-12859)
BORON CARBIDES
  crystal structure of carbon-saturated B_4C, 25:58344(R) (LA-4693)
BORON FLUORIDES
  solubility of gaseous, in fluoride melts, 25:57298 (ORNL-4676, pp 73-138)
BORON IONS
  implantation in silicon for use as charged-particle detectors, 25:57749
  ranges and stragglings in silicon at 20 to 400 keV, calculations of, 25:59116
  reactions with celluloid films of multiply charged, film-thickness dependence of cross sections for electron capture and loss in, (E), 25:58695
  wave functions for excited two-electron, Hulthen transform functions in approximation of, 25:58713
BORON ISOTOPES
  abundance in primary cosmic radiation, (E), 25:58833
  determination of, mass spectrometer for, 25:57890
BORON ISOTOPES B-11
  energy levels at 15.12, 15.80, and 16.7 MeV from beryllium-9 (d,α) reactions, spins, parities, and widths of, (E), 25:59827 (CEA-R-4070)
  neutron elastic and inelastic scattering at 14.1 MeV, coupled-channels calculation of angular distributions from, (T), 25:59720
  proton reactions (p,He-4), mechanisms for differential cross sections and angular distributions for, (E), 25:59711 (UCLA-10-P-18-32)
BORON ISOTOPES B-14
  mass excess of, predicted, (E), 25:59716
BORON ISOTOPES B-15
  mass excess of, predicted, (E), 25:59716
BORON NITRIDES
  crystal structure disorder in, effects of sintering on, 25:58359
  electron band structure from x-ray spectra, (E/T), 25:59178
  performance as lubricant for deep drawing nickel alloys and stainless steel, 25:58195
  sintering behavior of powdered, effects of powder preparation temperature on, 25:58358
  Al--BN, preparation of metal--matrix composites of, methods for, 25:58363
  AlN--BN, thermal conductivity of sintered compacts of, at 1000 to 1600°C, 25:58385
BORON SYSTEMS
  Al--B, fracture in continuous monolayer and bilayer composites of, microradiographic studies of, 25:58400
  B--graphite, diffusion of helium from irradiated, at 200 to 300°C, 25:58378
  B--plastics, properties of continuous filament reinforced, for use in space vehicles, 25:58422
BOSONS
  formalism for two-particle system with spins 0 and 1/2, quasipotential, (T), 25:59422 (JINR-E2-6046)
  interactions with spin-1/2 fermions in two-particle system, quasipotential equations for amplitude of, (T), 25:59422 (JINR-E2-6046)
  interactions with spinless bosons, radiative corrections to relativistic eikonal amplitude for scalar meson exchange in elastic, (T), 25:59453
  Regge poles for, properties of complex, 25:59434
  theory for dense system of, Brandow linked cluster expansion for, 25:59229
  theory for interacting system of, one-dimensional, 25:59230
  wave function for two-particle system with spins 0 and 1/2, quasipotential equations for, (T), 25:59422 (JINR-E2-6046)
BOSONS, INTERMEDIATE-VECTOR
  decay $W \to \mu + \nu$ from production in neutrino reactions (ν,μ^-W^+) with nuclei at high energies, 25:59410
  decay $W^+ \to \mu^+(e^+) + \nu$, μ^+ angular and momentum distributions for, (T), 25:59413
  production in neutrino reactions (ν,μ^-W^+) with nuclei at high energies, angular and energy distributions for, 25:59410
  production of W in $e^+ + e^-$ colliding-beam interactions, total cross sections for, 25:59383
  production of W^+ in $\nu + N \to \mu^- + W^+ + N$ interactions and ν reactions with iron, μ^- angular and momentum distributions for, (T), 25:59414
BRAIN
  fatty acid transport into, 25:60290 (UCLA-12-839)
  radiation dose to, during therapy of tinea capitis in children, use of Fricke dosimeter to measure absorbed x, 25:58012
  radiation effects on numbers of cysteine-rich glial cells in rat, effects of dose and head exposure on x, 25:58106
  radiation effects on ultrastructure of medullary tissue of rat, effects of dose on gamma, 25:58118
  radiotherapy of tumors of human, effectiveness of γ, 25:58069
  scintigraphy for measurement of blood circulation using injected xenon-133, 25:58058
  scintigraphy using metastable indium-113 and technetium-99-labeled pertechnetate, diagnostic value of, 25:58060
  scintigraphy using metastable technetium-99 for diagnosis of Schilder's disease, 25:58048

XUM

BRAZING ALLOYS
  development of bismuth-resistant, for molbydenum alloys, 25:58168 (ORNL-4676, pp 139-233)
BREMSSTRAHLUNG
  cross section for suprathermal proton, (T), 25:58837
  effects on leukocyte count, adrenal cortex, and thyroid of rats, 25:58107
  emission from silicon crystals under electron irradiation, (E), 25:59149
  emission of magnetic, gain from stimulated, (T), 25:58681
  production in backward $e^+ + e^- \to e^+ + e^- + m\gamma$ interactions at high energies, double-logarithmic approximation for cross sections for, (T), 25:59374
  production in backward $e^+ + e^-$ interactions at high energies, integral equation for cross sections from partial waves with multi-Regge poles for amplitudes of, (T), 25:59369
  production in electron reactions with metals, effects of target thickness and atomic number on, 25:59106
  production in $N + N \to N + N + \gamma$ interactions, review of, (E), 25:59241 (CONF-710915-2)
  reactions (γ,f) with bismuth-209 at 1000 MeV, mass yields from, (E), 25:59816
  reactions (γ,n) with calcium-40, nickel-60, and silicon-28 up to 35 MeV endpoint energy, excitation functions for, (E), 25:59772
  reactions (γ,n) with carbon-12, gold-197, iodine-127, manganese-55, and sodium-23, energy dependence of yields for, (E), 25:59815
  reactions (γ,n) with lead-208 at several hundred keV, cross section for, (E), 25:59778 (JAERI-Memo-4520)
  reactions (γ,n) with phosphorus-31 at 21.5 and 25.5 MeV, analysis for isospin effect in, (E/T), 25:59765
  reactions with carbon-12 at 4 GeV, real part of rho--N forward scattering amplitude and relative rho--ω production phase from, (E), 25:59252
  reactions with cesium-133 and lanthanum-139 at 250 MeV, analysis using residual nucleus method, (E), 25:59815
BROMINE
  determination as bromide using Chloramine-T, 25:57303
  determination in flour by heavy ion scattering, 25:57359
  determination of extracellular, in man, radioisotope dilution method for, 25:57924
  determination of trace amounts of, in pulp by neutron activation and γ spectrometry, 25:57383
  meson (π^-) inelastic scattering at 3.5 GeV/c with charged-particle evaporation, charged-particle energy spectra and angular distributions for, (E), 25:59822
BROMINE ISOTOPES Br-80
  isomeric transition in bromide--hexane systems, 25:57494
  isomeric transition in bromomethane, fragment distribution from, 25:57501
  reactions of recoil, from isomeric transition with methane, 25:57491
  reactions of recoil, from isomeric transition with bromomethane, 25:57492
BROMINE ISOTOPES Br-82
  reactions of recoil, from isomeric transition with bromomethane, 25:57492
  reactions of recoil, from isomeric transition with methane, 25:57491
BROOKHAVEN ALTERNATING-GRADIENT SYNCHROTRON (AGS)
  experimental facilities at, description of Yale--NAL CAMAC data acquisition system, 25:59658
BROOKHAVEN REACTOR
  loop operation in, experience with chemonuclear, 25:57610 (BNL-50293)
BROWNS FERRY POWER REACTOR, UNIT 1
  construction of, request for not suspending permit for, 25:59950 (DOCKET-50259-27)
BROWNS FERRY POWER REACTOR, UNIT 2
  construction of, request for not suspending permit for, 25:59950 (DOCKET-50259-27)
BROWNS FERRY POWER REACTOR, UNIT 3
  construction of, request for not suspending permit for, 25:59950 (DOCKET-50259-27)
BUBBLES
  diffusion in copper thin foils, effects of dislocations on, 25:58214 (RD/B/N-2023)
1,3-BUTADIENE
  yields from γ radiolysis of gaseous ethylene in presence of 2-methylpropene, 25:57474
BUTANE
  reactions of solid, with iodine ion beams at 3000 to 50 eV, 25:57499
  yields from γ radiolysis of gaseous ethylene in presence of 2-methylpropene, 25:57474
BUTANE, 1,2:3,4-DIEPOXY-
  effects of interaction with uv radiation on Neurospora, photoreactivation of mutagenic, 25:57954
BUTANE, 2,2-DIMETHYL-
  yields from γ radiolysis of gaseous ethylene in presence of 2-methylpropene, 25:57474
BUTANE, 2-METHYL-
  radioinduced luminescence of glasses of, containing olefins, γ, 25:57463
1,3-BUTANEDIONE, 4,4,4-TRIFLUORO-1-(2-THIENYL)-
  solvent properties for neptunium, 25:57535
2-BUTENE
  yields from γ radiolysis of gaseous ethylene in presence of 2-methylpropene, 25:57474
BUTENYNE
  yields from γ radiolysis of gaseous ethylene in presence of 2-methylpropene, 25:57474

C

CABLES
  dielectric insulator for superconducting, performance of helium as, 25:58950
CADMIUM
  deformation of monocrystals of, dynamics of high-strain-rate, 25:58252
  determination in pure rare earth oxides, polarographic, 25:57311
  determination in Zircaloy-2 by extraction and spectrophotometry, 25:57326
  determination using sodium azide as supporting electrolyte, polarographic, 25:57307
  mechanical properties of, effects of fatigue on, 25:58223
  microstructure of, effects of fatigue on, 25:58223
  photon reactions with, secondary electron emission from, (E/T), 25:59107
CADMIUM ALLOYS AND SYSTEMS
  Ag-base--Cd, precipitation in, effects of aluminum, beryllium, magnesium, scandium, and yttrium additions on periodic, 25:58262
  Cd--Mg, hardness of, 25:58253
CADMIUM ISOTOPES Cd-111
  neutron inelastic scattering at 14.8 MeV, cross sections and gamma spectra from, (E), 25:59797
CADMIUM ISOTOPES Cd-112
  neutron reactions (n,2n) at 14.8 MeV, cross sections and gamma spectra from, (E), 25:59797
CADMIUM TELLURIDES
  radiation effects on carrier content, Hall mobility, and photoconductivity of n- and p-type, 1.0-MeV electron and fission-neutron, 25:59161
CALCIUM
  abundance in solar corona, (E), 25:58605
  determination in Roanoke River water by neutron activation and γ spectrometry, 25:57395
  determination using glyoxal-bis(2-hydroxyanil), spectrophotometric, 25:57304
  electron reactions up to 1 keV with, total cross sections for ionization in, (E), 25:58777
  meson (μ^-) capture by, asymmetry coefficient for low-energy neutron angular distribution from, (E), 25:59738 (JINR-P1-6029)
  separation from other cations by solvent extraction, 25:57304
CALCIUM BROMIDES
  $CaBr_2$--hexane, bromine-80m isomeric transition in, reactions of recoils from, 25:57494
CALCIUM CARBONATES
  $CaCO_3$--polyethylene, radiation effects on mechanical properties and creep resistance of composites of, gamma, 25:58416(R) (RLO-2098-2)
CALCIUM IONS
  excitation of Ca XV in solar corona, (E), 25:58605
CALCIUM ISOTOPES
  energy level transitions of, structural corrections in pair conversion coefficients in M1, (T), 25:59861
CALCIUM ISOTOPES Ca-39
  energy level at 2.80 MeV, lifetime for, (E), 25:59771
CALCIUM ISOTOPES Ca-40
  binding and single-particle energies of, RPA calculation using self-consistent starting energies and higher-order corrections in Goldstone expansion, (T), 25:59723
  deuteron reactions (d,p) at 7 to 12 MeV, DWBA and impulse-approximation analyses of, (T), 25:59848
  deuteron reactions (d,p) with, effects of deuteron D state on, (T), 25:59841(R) (ORO-4119-1)
  energy levels from electron inelastic scattering, model analysis of, (E/T), 25:59736
  energy levels of, calculation for α-hole, 25:59757
  nucleon scattering at 14 MeV, optical-model analysis of, (T), 25:59744
  photon reactions (γ,n) up to 35 MeV endpoint energy, excitation functions for, (E), 25:59772
  production in stars from simple helium burning, (E), 25:58508
CALCIUM ISOTOPES Ca-45
  determination in soft tissues by liquid scintillation counting, 25:57361
  use as tracer to study losses from oxide coatings on lamp cathodes, 25:57660
CALCIUM ISOTOPES Ca-48
  proton reactions (p,γ) at 4 to 18 MeV, excitation function and gamma spectrum from, (E), 25:59742
  proton reactions $(p,n\gamma)$ near 2 MeV, γ and conversion electron spectra from, (E), 25:59756
CALCIUM OXIDES
  ion transport numbers for, at 900 to 1180°C under low oxygen potentials, effects of ion radius on, 25:58379
  CaO--La_2O_3, electric properties of solid electrolytes, 25:59193
  CaO--Nb_2O_5--SiO_2--TiO_2, liquidus of pseudo-ternary

  $CaO.Nb_2O_5$--$CaO.TiO_2$--SiO_2 plane of, 25:58390
  CaO--Y_2O_3, electric properties of solid electrolytes, 25:59193
  CaO--ZrO_2, electric properties of solid electrolytes, 25:59193

CALIFORNIUM
  oxidation potential for trivalent--tetravalent, 25:57437
  separation from other actinides by paper or thin-layer chromatography, 25:57553

CALIFORNIUM ISOTOPES Cf-252
  distribution in tissues of rats following intraperitoneal injection, 25:57922
  encapsulation of neutron sources of, properties of stainless steel and Zircaloy-2 for, 25:58242
  fission of, variance of number of neutrons emitted by individual fragments in spontaneous, (E), 25:59824
  production by target irradiation in HFIR and processing in TRU, 25:57524 (ORNL-TM-3343)
  properties of neutron sources of, 25:57661

CALORIMETERS
  calibration of INR and SKODA, in low-intensity reactor radiation fields, 25:57875 (INR-1319)
  calibration of thermodiverter, for measuring heat generated by radiation, 25:57879
  design and operation of thermo-diverger, for use in reactors, 25:57878

CALUTRONS
  ion deposition and implantation systems for, description of, 25:57650 (CONF-711002-, pp 10-20)

CALVERT CLIFFS POWER REACTOR, UNIT 1
  construction of, request for not suspending permit for, 25:59974 (DOCKET-50317-28)
  site for, meteorological data for, 25:59975 (DOCKET-50317-29)

CALVERT CLIFFS POWER REACTOR, UNIT 2
  construction of, request for not suspending permit for, 25:59974 (DOCKET-50317-28)
  site for, meteorological data for, 25:59975 (DOCKET-50317-29)

CAMERAS
  design of automated, for hot cell metallography, 25:57627

CANADA
  pump production in, development of facilities for centrifugal, 25:57608 (70-CNA-658)

CARBIDES
  machining of refractory, effects of carbon content in corresponding ranges of homogeneity on electroerosion, 25:58356

CARBON
  abundance in sunspots, (E/T), 25:58589
  abundance of molecular, in delta Scu, (E), 25:58479
  activity in carbide fuels, effects of refractory metal additions on, 25:58163(R) (AI-AEC-12859)
  alpha reactions at 880 MeV, cross sections for production of beryllium-9 and -10 in, (E), 25:59733
  content in loop sodium, monitoring of, 25:58166(R) (AI-AEC-12980)
  determination by combustion in stream of nitrogen, oxidation, and gravimetry, 25:57349
  determination in beryllium by γ activation, nondestructive, 25:57385
  determination in liquid sodium, development of on-line meter for, 25:60058(R) (ANL-7817)
  determination in semiconductor-grade silicon by proton activation, 25:57396
  diffusion of oxygen through layers of, effects of electric field on, 25:58383
  diffusion of pyrolytic, in carbon felt, 25:58352 (Y-DA-2123(Rev.1))
  effects of interstitial, on stress rupture of Type 316 stainless steel, 25:58166(R) (AI-AEC-12980)
  effects on ductility of crystallized molybdenum wire, 25:58269
  effects on mechanical properties of molybdenum and tungsten single crystals, 25:58257
  effects on resistance of refractory carbides to electroerosion machining, 25:58356
  electron reactions at 0.3 to 1.1 MeV with foils of, transition radiation in light emitted by, 25:58686
  graphitization of fibers of, at high temperatures, mechanisms of, 25:58382
  graphitization of lamp black pitch, effects of temperature on, 25:58168 (ORNL-4676, pp 139-233)
  interactions with hydrogen in interstellar medium, cross sections for transitions of fine structure components of, (E/T), 25:58623
  joining of felt-type, development of methods for, 25:58352 (Y-DA-2123(Rev.1))
  neutron coherent atomic scattering amplitudes for, (E), 25:59696
  optical properties of foils of, from light emission during electron irradiation, 25:58686
  photon reactions (γ,α) with, pulse-height spectra from, (E), 25:59734
  photon reactions at 560 MeV, emulsion study of dependence on atomic weight for yields of π^+ and π^- from, (E), 25:59248
  photon scattering by, analysis for double scattering and glory effects in Compton, (T), 25:59703
  preparation of thin films of, method for, 25:58346 (CONF-711002-, pp 144-6)
  properties of felt-type, infiltrated with pyrolytic carbon, 25:58352 (Y-DA-2123(Rev.1))
  solubility in sodium at high temperatures, 25:58163(R) (AI-AEC-12859)
  transport in sodium--steel systems, kinetics of, (E), 25:60058(R) (ANL-7817)

CARBON BLACK
  carbon black--polyethylene, radiation effects on mechanical properties and creep resistance of composites of, gamma, 25:58416(R) (RLO-2098-2)
  carbon black--polystyrene, radiation effects on composites of, gamma, 25:58416(R) (RLO-2098-2)

CARBON DIOXIDES
  analysis of atmospheric, for carbon-14, radiometric, 25:57364
  electron reactions at 13 and 17 eV with, production of oxygen ions (O^-) by dissociative attachment in, (E), 25:58730
  electron reactions at 60 eV with, production of excited oxygen ions (O^+) in, (E), 25:58763
  electron reactions up to 300 eV with, cross sections for emission produced by dissociative excitation, excitation, and ionization in, (E), 25:58760
  electron reactions with, formation of metastable carbon monoxide and oxygen by dissociation in, (E), 25:58765
  electron reactions with, K--LL Auger spectra from, (E), 25:58736
  iodine-ion reactions at 12 MeV with, electron-capture and -loss cross sections for, (E), 25:58768
  radiolysis of gaseous, at high density, γ, 25:57461

CARBON IONS
  effects on swelling in Type 316 stainless steel at 20 MeV, relations with cold work, 25:58324
  effects on void formation in cobalt at 100 kV, 25:58325
  effects on void swelling in nickel, Type 316 stainless steel, and Nimonic PE 16 at 20 MeV, relations with dose, 25:58322
  effects on void swelling in Type 18/8/Ti stainless steel at 20 MeV, relations with temperature, 25:58323
  effects on void swelling in Type 316 stainless steel at 20 MeV, relations with temperature, 25:58321
  electron reactions with C^+, cross sections for ionization in, (E), 25:58769
  reactions with deuterium molecules, effects of thermal motion of molecules on charge exchange in, (T), 25:58752
  spectral emission line intensities of, in solar transition region, (E), 25:58599

CARBON ISOTOPES C-12
  carbon-12 reactions (C-12,α) at 22.0 to 35.5 MeV, differential cross sections, excitation functions, and spectra from, (E), 25:59717
  cluster states in, reaction-matrix theory of triangular and linear-chain, (T), 25:59724
  deuteron elastic scattering at 80 MeV, optical-model analysis of angular distributions from, (E), 25:59754
  deuteron inelastic scattering at 82 MeV, DWBA analysis of angular distributions from, (E), 25:59754
  deuteron reactions (d,p) at 80.2 MeV, DWBA analysis of differential cross sections for, (E), 25:59754
  electron reactions with, production of meson (π) in bound state from, 25:59355
  electron scattering at high energy, analysis using oblate deformed model, (T), 25:59729
  energy levels from electron inelastic scattering, model analysis of, (E/T), 25:59736
  energy levels from inelastic scattering, deformation parameters for, (E), 25:59754
  energy levels of, calculation for giant resonance, (T), 25:59732
  energy-level transitions in μ^- and π-mesic atoms of, cascade processes and x-ray emission in, (T), 25:58724
  lithium-7 reactions (Li-7,2p) at 30 MeV, cross sections and Q-value spectra from, (E), 25:59716
  meson (π) scattering at 120 to 1200 MeV, angular distribution and total cross section for, (T), 25:59712
  meson (π^-) elastic scattering at 120 to 260 MeV, Coulomb--nuclear interference and differential cross sections for, (E), 25:59713
  meson (π^-) elastic scattering at 180 MeV, Glauber approximation for differential cross sections for, (E), 25:59523
  meson (π^-) radiative capture by, calculation using impulse approximation with Cohen-Kurath wave functions, (T), 25:59730
  meson reactions (π^+,p) at 70 MeV, excitation energy spectra and upper limits for cross sections for, (E), 25:59710 (LA-DC-12781)
  nitrogen-14 reactions (N-14,Li-6) at 60.0 MeV, energy spectrum from, (E), 25:59743
  oxygen-16 reactions (O-16,α) at 28.9 MeV, α-γ angular correlations from, (E), 25:59767
  oxygen-16 reactions (O-16,p) at 36 and 60 MeV, angular distributions and spectra from, (E), 25:59714
  oxygen-16 reactions (O-16,p) with, p-γ angular correlations from, (E), 25:59761
  photon reactions (γ,n) with, energy dependence of yield for, (E), 25:59815
  photon reactions at 4 GeV, real part of rho--N forward scattering amplitude and relative rho--ω production

XUM

    phase from, (E), 25:59252
  production in stars from simple helium burning, (E), 25:58508
  proton elastic scattering at 1 GeV, analysis using Glauber theory and α-particle model, (T), 25:59727
  proton reactions at 0.1 to 660 MeV, intranuclear cascade model for, (T), 25:59265 (JINR-P2-5991)
  proton reactions at 1 TeV, effect of intermediate resonance production on cross sections for elastic and inelastic, 25:59519
  reactions (C-12,α) with carbon-12 at 22.0 to 35.5 MeV, differential cross sections, excitation functions, and spectra from, (E), 25:59717
  reactions (C-12,xn) and (C-12,αxn) with tellurium-130 above 10 MeV/nucleon, excitation functions, compound nucleus production cross section energy dependence, angular momentum, and evaporation cross section ratio energy dependence for, (E), 25:59779 (JINR-P7-5912)
CARBON ISOTOPES C-13
  alpha reactions (α,n) at 1 to 5.5 MeV, excitation functions and Hauser--Feshbach calculations of spectra from, (T), 25:59708 (BNWL-B-109)
  effects on ir spectra of hydrogen cyanide, 25:57421
  energy levels at 3.86 MeV, lifetime for, (E), 25:59771
  energy levels from carbon-12 (d,p) reactions, spectroscopic factors for, (E), 25:59754
  meson (π^+) reactions (π^+,π^0) at 180 MeV, Glauber approximation for differential cross sections for, 25:59523
  reactions (C-13,xn) and (C-13,αxn) with tellurium-130 above 10 MeV/nucleon, excitation functions, compound nucleus production cross section energy dependence, angular momentum, and evaporation cross section ratio energy dependence for, (E), 25:59779 (JINR-P7-5912)
CARBON ISOTOPES C-14
  determination by combustion in nitrogen stream, oxidation, and scintillation counting, 25:57349
  determination in atmospheric carbon dioxide and biological samples, radiometric, 25:57364
  determination in carbonates by conversion to carbon dioxide and counting, 25:57358
  determination in labeled compounds, performance of scanners, autoradiographs, and liquid scintillation detectors for, 25:57752
  effects of recoils of, on polymerization of neutron-irradiated benzene or toluene, 25:57456
  fabrication of self-supporting targets of, methods for, 25:59639 (CONF-711002-, pp 134-43)
CARBON ISOTOPES C-17
  mass excess of, predicted, (E), 25:59716
CARBON MONOXIDES
  abundance in delta Sco, (E), 25:58479
  abundance in sunspots, (E/T), 25:58589
  deuterium-hydride scattering by, velocity dependence of total effective cross sections for, 25:58782
  deuterium-molecule scattering by, velocity dependence of total effective cross sections for, 25:58782
  electron reactions at 16 to 18 eV with, production of oxygen ions (O^-) by dissociative attachment in, (E), 25:58730
  electron reactions up to 300 eV with, cross sections for emission produced by dissociative excitation, excitation, and ionization in, (E), 25:58759
  electron reactions with, K--LL Auger spectra from, (E), 25:58736
  helium-atom scattering by, velocity dependence of total effective cross sections for, 25:58782
  reactions with amorphous uranium trioxide, 25:57417
CARBON SYSTEMS
  Al--C, preparation of metal-matrix composites of, methods for, 25:58363
  C--Cr--Fe--Hf--Mn--Mo--Nb--Ni-base--Si--Ti--Zr, radiation effects on mechanical properties of, relations of composition with thermal neutron, 25:58168 (ORNL-4676, pp 139-233)
  C--Cr--Fe--Ni--Si--W, metallography of carbide structures in cast heat-resistant, 25:58399
  C--Mo--Ni, phase composition in molybdenum-rich solutions of, at 1200 to 1800°C, 25:58290
  C--Mo--Zr, phase studies of, 25:58273
  C--Mo-base, crystallization and carbide phase formation in, effects of carbon content on, 25:58282
  C--Ni, preparation of metal-matrix composites of, methods for, 25:58363
CARBONATES
  analysis for carbon-14 by conversion to carbon dioxide and counting, 25:57358
  polymers, reactions with fluorine, 25:57619 (RFP-1739)
CARCINOGENS
  effects on initiation of human umbilical cord leukocyte cell cultures, 25:57921
CARDIAC PACEMAKERS
  development of plutonium-238-fueled, fabrication and testing of prototype models for, 25:57657(R) (NUMEC-4189-6)
  heat source for, design of plutonium-238-fueled alpha-particle, 25:57668(P)
  testing of plutonium-238-fueled implantable, 25:57669
CAROTENOIDS
  radiation effects on synthesis of, in Japanese persimmons, effects of dose on electron, 25:57926
CASCADE IMPACTORS
  calibration for size measurement of submicron aerosol particles at low pressure, 25:57573 (ORNL-4226)
CASCADE SHOWERS
  production of intranuclear, in proton reactions with carbon-12 at 0.1 to 660 MeV, model for, (T), 25:59265 (JINR-P2-5991)
CASTING
  methods for actinide metal radiation targets, 25:59634 (CONF-711002-, pp 59-69)
CASTINGS
  inspection of thick, betatron radiography method for, 25:57678 (INR-1204)
CATALASE
  Moessbauer spectroscopy of, 25:60279(R) (NYO-3798-12)
CATTLE
  iodine-131 content of milk of, following ingestion of hay contaminated with Plowshare debris, 25:57948 (SWRHL-85-r)
CAVITIES
  construction of underground, for chemical and metallurgical processing, use of nuclear explosions for, 25:57604 (UCRL-73130)
  stemming conditions in underground nuclear explosion emplacement, method for pre-shot calculation of, 25:57607
CELL DIVISION
  radiation effects on, in epidermis of human mammary tumors, x, 25:58146
CELLOPHANE
  photon reactions (γ,α) in, pulse-height spectra from, (E), 25:59734
CELLS
  iodine-125-labeled gamma globulin uptake by intestinal epithelial, in neonatal rats, 25:60278 (NYO-3515-6)
  phagocytic response of rat lung, following exposure to uranium oxide, 25:57923
  radiation effects on ability of salamander limb, to participate in regeneration, 25:58103
  radiation effects on count of mouse bone marrow stem, effects of partial marrow shielding on x, 25:58124
  radiation effects on cricket neurosecretory, effects of nymph head exposure dose on x, 25:58095
  radiation effects on dog hypothalamus neurosecretory, acute whole-body x, 25:58129
  radiation effects on mammalian, review of effects of LET on charged particle, neutron, and x, 25:58089
  radiation effects on mammalian, review of relation between recovery and dose rate in, 25:58088
  radiation effects on numbers of rat brain cysteine-rich glial, effects of dose and head exposure on x, 25:58106
  radiation effects on sensitivity of lymphoid, to antisera in mouse bone marrow, x, 25:58120
  radiation effects on survival of mouse ascites tumor, sensitizing effects of iodoacetamide on, 25:58034
  radioinduced breaks in DNA of mammalian, review of repair mechanisms for uv and x, 25:57943
  radiosensitivity of melanoma, in comparison to HeLa cells, effects of cytoplasmic inclusions on x, 25:58085
  response to nucleic acid penetration, 25:60282(R) (ORO-3885-3)
  transplantation of osteogenic precursor, of bone marrow to lethally irradiated hybrid mice, effects of hematopoietic cells on, 25:58121
CELLS, CULTURED
  radiation effects on human umbilical cord leukocyte, comparison of effects of chemical carcinogens, viruses, and x, 25:57921
  radiation effects on mammalian, role of labeled DNA in lethal tritium beta, 25:58086
  radiation effects on mitotic activity of human cancer, additive effects of colchicine on γ, 25:58080
  radiation effects on survival of Chinese hamster and human liver, effects of incubation in conditioned medium on repair of x, 25:58081
  radioinduced death of mammalian, mechanism of tritium beta, 25:58086
  radioinduced interphasic death in human, following microbeam exposure of cytoplasm or nucleus, uv, 25:58084
CELLS, HeLa
  radiation effects on growth and mitotic index of, effects of 5-fluorouracil on uv, 25:58082
  radiosensitivity in comparison to melanoma cells, effects of cytoplasmic inclusions on x, 25:58085
  radiosensitivity of, effects of 5-fluorouracil on uv, 25:58082
CELLS, KB
  radiation effects on survival of, effects of cyclic AMP and hydrocortisone on uv, 25:58087
CELLULOID
  ion reactions with films of, film-thickness dependence of cross sections for electron capture and loss in, (E), 25:58695
CELLULOSE, CARBOXYMETHYL ETHER
  radiation effects on aqueous solutions of, at -170 to 25°C, 1-MeV electron, 25:57443
CENTRAL AMERICA
  fallout monitoring during 1970, 25:57981(R) (HASL-245(App.))

  radioactivity of surface atmosphere and precipitation sampled during March 1971, gross β, 25:57992
  radioisotope content of milk during March 1971, barium-140, cesium-137, iodine-131, strontium-89, and strontium-90, 25:57950
CENTRIFUGES
  bearings for, design of improved vertical-axis rotor, 25:57634(P)
  design of K-XII zonal, for purification of influenza virus, engineering drawings for, 25:57626
CERAMIC MATERIALS
  book: Radiation Effects on Glass and Ceramics, in Russian, 25:59147
CEREALS
  flour, analysis for bromine by heavy ion scattering, 25:57359
CEREBROSPINAL FLUID
  scintigraphy of flow kinetics of dog, use of indium-111-labeled albumin for, 25:58052
CERIUM
  abundance on surfaces of peculiar A stars, (E/T), 25:58462
  determination by paper chromatography using peroxide method, 25:57331
  determination in refractory alloys following chromatographic separation from interfering metals, photometric, 25:57338
  determination in silicate rocks by neutron activation, low-energy photon detector for, 25:57387
  oxidation potential for trivalent--tetravalent, 25:57437
  separation from fission products by electromigration following complexing with nitrilotriacetic acid, 25:57558
  separation from other rare earths by electrophoresis in Complexon III on cellulose or silica gel, 25:57299
  separation of berkelium from, by sorption on zirconium phosphate--silicate, 25:57530
  solubility in chromium at 1000 to 1800°C, metallographic, microhardness, and x-ray diffraction measurements on, 25:58237
CERIUM ALLOYS AND SYSTEMS
  Ce--Y-base, Kondo temperature and superconducting transition temperature of, effects of pressure on, 25:59195
CERIUM IONS
  energy level calculations for Ce III, using Hartree--Fock method, 25:58709
  luminescence in lanthanum and cerium phosphate phosphors, effects of thorium ions on, 25:59185
CERIUM ISOTOPES Ce-140
  energy levels of, determination of electromagnetic transition probabilities from mean lifetimes of, (E), 25:59776 (FRNC-TH-56)
CERIUM ISOTOPES Ce-144
  chemical state in seawater, effects of iron on, 25:57410
  content in rainwater at Fayetteville, Arkansas from May 1966 to Jan. 1969, 25:57578
CERIUM OXIDES
  BaO--CeO_2, phase equilibria in, 25:58405
  CeO_2--ThO_2, electric conductivity of $CeO_2 \cdot 3ThO_2$ solid solutions at 1000 to 1500°C and varying oxygen pressure, 25:58368
CERIUM PHOSPHATES
  luminescence of cerium and terbium ions in, effects of thorium ions on, 25:59185
CERN SYNCHROTRON
  power supplies for improvement program at, 25:59662
  power supply for main ring magnets of, 25:59663
CESIUM
  determination in seawater by AMP precipitation and emission photometry, 25:57301 (TID-25776)
  determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
  effects on complexonometric determination of rare earths, 25:57317
  electromigration in molten chlorides, 25:57439
  electron reactions with, cross sections for ionization in, (T), 25:58738
  plasma of, ionization of nonequilibrium low-pressure, excited states in, (T), 25:59008
  plasma of, population of ionization levels in, 25:59034
  separation from MSBR fuel solvent by reductive extraction, 25:57298 (ORNL-4676, pp 73-138)
  separation of berkelium from, by sorption on zirconium phosphate--silicate, 25:57530
CESIUM IODIDES
  neutron reactions (n,a) and (n,p) at 12 to 22 MeV, analysis for pre-equilibrium emission mechanism in, (E/T), 25:59826
CESIUM ISOTOPES Cs-129
  evaluation for scintigraphy of myocardium in dogs, 25:58041 (UCLA-12-837)
CESIUM ISOTOPES Cs-133
  neutron capture at 400 keV, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801
  photon reactions at 250 MeV, analysis using residual nucleus method, (E), 25:59815
CESIUM ISOTOPES Cs-134
  determination in reactor effluent water by ion exchange and γ spectroscopy or radiochemical methods, 25:57351
  determination in seawater by precipitation using AMP and γ counting, 25:57348 (TID-25777)
CESIUM ISOTOPES Cs-137
  content in Japanese atmosphere, 1963 to 1971, 25:57579
  content of milk in Europe, New Zealand, and USA during 1970, 25:57980(R) (HASL-245)
  detection of fission-product, use in locating holes in fuel cans, 25:58344(R) (LA-4693)
  determination in environmental samples by radiochemical isolation and γ spectrometry or beta detection, 25:57355
  determination in reactor effluent water by ion exchange and γ spectroscopy or radiochemical methods, 25:57351
  determination in seawater by precipitation using AMP and γ counting, 25:57348 (TID-25777)
  excretion and retention time in man following acute or chronic intake, method for calculation of, 25:57919
  preparation of beta sources of, Elan-2B pilot plant for, 25:57482(T) (ORNL-tr-2535)
CESIUM URANIUM FLUORIDES
  crystal structure, 25:57298 (ORNL-4676, pp 73-138)
CESIUM URANYL NITRATES
  symmetry types of uniaxial and biaxial crystals of, 25:58703
CHALKS
  effects on thermostability of irradiated polyethylene, 25:57446
CHAPELCROSS REACTORS
  fuel element failure in Unit 2, recovery operations following, 25:59923
CHARCOAL
  sorptive properties of activated, for methyl iodide, (T), 25:60088
CHARGED-PARTICLE BEAMS
  interactions with plasma, diagnostic use of, 25:58994
  oscillations in modulated slightly relativistic, (T), 25:59211
CHARGED PARTICLES
  dechanneling by lattice defects in crystals, review, 25:59169
  detection and identification in ΔE--E telescopes, design and performance of analog equipment for, 25:57722 (CEA-R-4183)
  detection of, development of glass chamber detectors using liquid--liquid phase separation for, 25:57727
  detection of, physical properties and scintillation performance of barium fluoride for, 25:57817
  effects on mammalian cells, review of effects of LET on repair of, 25:58089
  energy loss distribution in single crystals of heavy positive, effects of channeling on, (T), 25:59150
  motion in approximately orthogonal electric and magnetic fields, (T), 25:59210
  motion in axially symmetric time-varying magnetic fields, (T), 25:59212
  motion in magnetic and varying electric fields, potential distribution in, (T), 25:59231
  motion in magnetosphere core, review of trapped, (E/T), 25:58910
  motion in medium, strong correlation between properties of photon tachyons of disappearing Fresnel wave and Cherenkov effect for, (T), 25:59573
  occurrence at lower latitudes of trapping region boundary, nonadiabatic behavior of, (E/T), 25:58907
  production of nonrelativistic doubly, in cosmic multicharged nuclei reactions with light nuclei above 700 MeV/nucleon in emulsions, energy distribution and mean energy for, (E), 25:59274
  radiations from spinless, in electromagnetic field with two waves traveling toward each other, (T), 25:59226
  ratio to neutral particles at altitudes of 800 gm/cm^2, (E), 25:58834
  scattering by single crystals, quantum/classical transition in, (T), 25:59157
  trapping in unstable radiation zone, (E/T), 25:58906
CHELATING AGENTS
  effectiveness of polycomplexon, for removing cobalt-60 from human skin in comparison to DTPA and EDTA, 25:57982
CHEMICAL REACTIONS
  yields in closed systems from, effects of initial conditions and rate constants on, 25:57411
  yields in open system, conditions determining, 25:57413
CHERENKOV RADIATION
  suppression of, Fourier transform criterion for, (T), 25:59219
CHIMERAS
  use of mouse radiation, for studies on osteogenic precursor cells of bone marrow, 25:58121
CHINON REACTORS (EDF-3)
  control system for, development of automatic, 25:59894
CHLORIDES
  electromigration of ions in molten, 25:57439
CHLORINE
  abundance in Orion Nebula, (E), 25:58593
  abundance in Sun, (E), 25:58593
  determination as chloride using Chloramine-T, 25:57303
  determination in analytical reagents by neutron activation, 25:57379
  determination in Roanoke River water by neutron activation and γ spectrometry, 25:57395

XUM

  neutron coherent atomic scattering amplitudes for, (E), 25:59696
CHLORINE IONS
  abundance in Orion Nebula, (E), 25:58513
  effects on subsequent valence distribution of sulfur-35 ion implanted in sodium chloride crystals, 25:57503
  spectral lines in Orion Nebula due to, (E), 25:58513
CHLORINE ISOTOPES Cl-35
  electron reactions with, production of meson (π) in bound state from, 25:59355
  neutron capture by, gamma linear polarization and coincidence spectrum from thermal, (E), 25:59745
CHLORINE ISOTOPES Cl-36
  energy levels from chlorine-35 neutron capture, spin--parity assignments for, (E), 25:59745
  energy-level transitions from chlorine-35 neutron capture, E2/M1 mixing ratio for, (E), 25:59780 (KFK-1401)
  energy-level transitions from chlorine-35 neutron capture, E2/M1 mixing ratios for, (E), 25:59745
CHLOROPHYTA
  Chaetomorpha melagonium, radioinduced chromosome aberrations in, effects of dose on beta, 25:58153
  Chlamydomonas reinhardi, radiation effects on DNA synthesis in, dark repair of uv, 25:57925
5β-CHOLANIC ACID, 3,7,12-TRIOXO-
  effects on excretion of plutonium-239 by rats, 25:57998 (NIRS-Pu-8)
CHOLINESTERASE
  radiation effects on activity in brain and heart of rats, effects of adrenal hormones on x, 25:57929
CHROMIUM
  abundance in Am stars, (E/T), 25:58438
  activity in chromium--titanium alloys, effects of hydrogenation on, 25:58220
  complexes with 2,4-pentanedione, radiation effects on, study of thermal annealing mechanism in neutron, 25:57496
  complexes with 2,4-pentanedione, radioinduced transfer in chromium-51-doped, neutron, 25:57496
  complexes with 2,4-pentanedione, thermal transfer or exchange in chromium-51-doped, 25:57496
  content of foods in Kiev region of Soviet Union, 25:57987
  determination by extraction using quinolinol melt and spectrography, 25:57312
  determination in fuel solutions of JRR-1, 25:57320
  determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
  determination of trace amounts of, in tungsten trioxide or zirconium dioxide, effects of halide additives on direct spectrographic, 25:57335
  determination using sodium azide as supporting electrolyte, polarographic, 25:57307
  diffusion of molybdenum atoms in films of, ion--ion emission studies on, 25:58266
  effects on hardness of dispersion-hardening iron-base alloys, 25:58235
  effects on niobium nitride solubility in iron austenite, 25:58268
  effects on recovery of aluminum irradiated with fast neutrons, 25:58303
  electric conductivity of laser-evaporated films of, temperature coefficient of, 25:59186
  proton elastic scattering at 40 MeV, differential cross sections for, (E), 25:59739 (ORNL-TM-3591)
  radioinduced helium production in, measurement of in-pile, 25:58163(R) (AI-AEC-12859)
  reactions with arsenic and plutonium, 25:57413
  reactions with plutonium in presence of acetaldehyde and arsenite, 25:57411
  separation from plutonium by solvent extraction using TBP, 25:57357
  solubility in sodium at high temperatures, 25:58163(R) (AI-AEC-12859)
  solvent properties for cerium, neodymium, and praseodymium at 1000 to 1800°C, 25:58237
  solvent properties for nitrogen at high temperatures, 25:58249
CHROMIUM ALLOY COUPLES
  Cr--Ni-base/Ni-base--Si, development of thermocouple of, 25:57876
CHROMIUM ALLOYS AND SYSTEMS
  Al--Cr--Mo--W, development of cast, for turbine blades, 25:58203
  Al--Cr--Ni-base--Ti, radiation effects on mechanical properties of, relations of temperature with neutron, 25:58295 (FRNC-TH-64)
  C--Cr--Fe--Hf--Mn--Mo--Nb--Ni-base--Si--Ti--Zr, radiation effects on mechanical properties of, relations of composition with thermal neutron, 25:58168 (ORNL-4676, pp 139-233)
  C--Cr--Fe--Ni--Si--W, metallography of carbide structures in cast heat-resistant, 25:58399
  Co-base--Cr--ThO_2, properties for use in turbine vanes, 25:58203
  Cr--Ni, porosity and pressure strength of boron-containing, for use as neutron absorber, 25:58255
  Cr--Ni, production of boron-containing neutron absorbers of, using powder metallurgy, 25:58255
  Cr--Ti, chromium activity in, effects of hydrogenation on, 25:58220
  Cr--Ti--V-base, radiation effects on tensile properties of, alpha particle, 25:58163(R) (AI-AEC-12859)
  Cr--W, uses for milling surface-hardened specimen by hard-facing process, 25:58196
  Cr--Zr-base, properties of dilute cast, electric and mechanical, 25:58258
CHROMIUM ISOTOPES Cr-48
  energy levels of, calculation for α-hole, 25:59757
  production in stars from simple helium burning, (E), 25:58508
CHROMIUM ISOTOPES Cr-50
  preparation of radiation targets of, procedures for electrolytic, 25:59633 (CONF-711002-, pp 39-46)
  use as tracer in measuring erosion of high-pressure pipe fittings, 25:57662
CHROMIUM ISOTOPES Cr-51
  content in Columbia River sediments, (E), 25:57561 (TID-25786)
  exchange between chromium compounds and potassium trisoxalato chromate, 25:57490
  radioinduced or thermal transfer in doped chromium trisacetylacetone, neutron, 25:57496
  reactions of recoil, in neutron-irradiated chromium trisacetylacetone, 25:57496
  reactions of recoil, in neutron-irradiated potassium trisoxalato chromate, 25:57490
CHROMIUM ISOTOPES Cr-52
  helium-3 elstic scattering at 30 and 32 MeV, optical-model analysis of differential cross sections for, (E), 25:59769
  preparation of radiation targets of, procedures for electrolytic, 25:59633 (CONF-711002-, pp 39-46)
CHROMIUM ISOTOPES Cr-53
  helium-3 elastic scattering at 32 MeV, optical-model analysis of differential cross sections for, (E), 25:59769
  preparation of radiation targets of, procedures for electrolytic, 25:59633 (CONF-711002-, pp 39-46)
CHROMIUM ISOTOPES Cr-54
  preparation of radiation targets of, procedures for electrolytic, 25:59633 (CONF-711002-, pp 39-46)
CHROMOSOMES
  gene localization in Drosophila, for x-radioinduced suppressor mutations, 25:57975
  radiation effects on behavior of parthenogenetic wasp, x, 25:57962
  radiation effects on somatic crossing over in Drosophila X, effects of oxygen on x, 25:57959
  radioinduced aberration frequency in human peripheral lymphocyte, effectiveness as dosimeter in accidental exposure to radium-226, 25:58016
  radioinduced aberration frequency in peripheral human lymphocyte, effectiveness for measuring low-dose occupational exposures, 25:58015
  radioinduced aberration frequency of peripheral human lymphocyte, effectiveness as biological dosimeter of, 25:58013
  radioinduced aberrations in fibroblast and lymphocyte, of children with Fanconi's anemia, γ, 25:57973
  radioinduced aberrations in medical personnel, effects of dose, dose fractionation, and radiation source on γ, neutron, and x, 25:57972
  radioinduced aberrations of bacterial, role of DNA repair in recovery of, 25:57970
  radioinduced aberrations of Chaetomorpha, effects of dose on beta, 25:58153
  radioinduced aberrations of Crepis capillaris seed, effects of time of onset of mitosis on frequency of fast neutron, γ, and x, 25:57968
  radioinduced aberrations of human peripheral lymphocyte, effectiveness as biological dosimeter of, 25:58014
  radioinduced aberrations of, in human peripheral lymphocytes, review of, 25:57963
  radioinduced disjunction and loss of Drosophila X, use of frequency of, as dosimeter, 25:57999 (NP-18944)
  radioinduced DNA synthesis in Drosophila polytene, uv and x, 25:57951 (COO-1747-6)
  radiosensitivity of barley seed, from plants grown at high altitudes, effects of uv-deficient light conditions on γ, 25:57969
CHROMOSPHERE
  acoustic waves in, propagation of α spectrum of, (T), 25:58579
  electric conductivity in lower, (E/T), 25:58588
  flocculi in, effects of planets on distribution of calcium, (E), 25:58611
  heating of, due solar spicules, (T), 25:58619
  helium abundance in, (E), 25:58602
  model of, (E), 25:58602
  transition layer with corona, model for, (E/T), 25:58580
CIRCUITS
  analysis using computers, operational amplifier models for, 25:60289 (SC-RR-710628)
  design and performance of analog, for charged-particle identification in ΔE--E telescopes, 25:57722 (CEA-R-4183)
  design and performance of beam energy control and monitoring, for FN tandem Van de Graaff accelerators, 25:59653
  design for four-decade digital log ratemeter, 25:57893

XUM

CITRIC ACID
  radiolysis in nitric acid--strontium nitrate solutions, γ, 25:57457 (ARH-2163)
CLAYS
  analysis for trace amounts of elements by resonance neutron activation and γ spectrometry, 25:57375
CLOTHING
  decontamination of footwear, worn in nuclear facilities, design and operation of ultrasonic equipment for, 25:57629
COAL
  economics of, cost--benefit analysis of, 25:59921
COATINGS
  book: Radiation Stability of Lacquer Coatings, 25:58420
COAXIAL CABLES
  filters for, method for design of near-optimum, 25:57892
COBALT
  compatibility with fuel capsule materials at high temperatures, 25:57654(R) (DP-1279)
  complexes, radiation effects on trisoxinato-, reactions of recoil cobalt-60 from, 25:57493
  determination by extraction using quinolinol melt and spectrography, 25:57312
  determination in cobalt alloys, spectrographic, 25:57313
  determination in iron meteors, pyrite, and pyroxene by neutron activation and γ spectrometry, 25:57386
  determination in nickel, radiometric, 25:57356
  determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
  determination of trace amounts of, in tungsten trioxide or zirconium dioxide, effects of halide additives on direct spectrographic, 25:57335
  determination using sodium azide as supporting electrolyte, polarographic, 25:57307
  diffusion in plutonium and plutonium alloys, tracer studies of, 25:58212 (NRCN-268)
  effects on hardness of dispersion-hardening iron-base alloys, 25:58235
  effects on mechanical properties of molybdenum single crystals, 25:58257
  effects on oxidation of hexavalent neptunium by potassium persulfate, 25:57412
  preparation of radiation targets of, by argon ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
  radioinduced helium production in, measurement of in-pile, 25:58163(R) (AI-AEC-12859)
  radioinduced void formation in hcp and fcc phases of, 100-kV carbon-ion and 1-MV electron, 25:58325
  solubility in sodium hydroxide--sodium nitrate solutions, 25:58177
COBALT ALLOYS AND SYSTEMS
  analysis for main components, spectrographic, 25:57313
  crystal structure of, electron microscopy and optical studies on relation of physical properties to, 25:58403
  oxidation resistance of WI-52, at 1500 to 2000°C in air, 25:58203
  preparation of high-strength heat-resistant superalloys of, review of methods for, 25:58203
  Al--Co--Cu--Fe-base--Ni, properties and structure of, effects of neodymium additions on, 25:58250
  Co--Fe-base--Mo, hardness of dispersion-hardening hard facing, effects of primary and secondary additions on, 25:58235
  Co--Fe-base--Mo--Ni, aging of, dilatometric, electric conductivity, and electron microscopy studies on, 25:58232
  Co--Fe-base--W, hardness of dispersion-hardening hard facing, effects of primary and secondary additions on, 25:58235
  Co--V, structural transformations in molten, relations of vacancy mechanisms with eutectic--peritectic, 25:58281
  Co--WC, dynamic behavior of cemented, effects of defects on, (T), 25:58380
  Co--WC, production and properties of, 25:58261
  Co--WC, solubility in sodium hydroxide--sodium nitrate solutions, 25:58177
  Co--Zr-base, properties of dilute cast, electric and mechanical, 25:58258
  Co-base--Cr--ThO_2, properties for use in turbine vanes, 25:58203
  Co-base--Fe--Mo--Ti, magnetic properties of wires of, 25:59197
  Co-base--Nb, microstructure of decomposing supersaturated solid solutions, 25:58280
COBALT ISOTOPES Co-56
  beta and electron-capture decay of, γ spectra from, (E), 25:59763
  beta decay of, β--γ circular polarization correlations and Coulomb and Fermi matrix elements in, (E), 25:59746
COBALT ISOTOPES Co-57
  chemical state in seawater, effects of iron on, 25:57410
  preparation of Moessbauer sources of, 25:59203
COBALT ISOTOPES Co-58
  beta decay of, β--γ circular polarization correlations and Coulomb and Fermi matrix elements in, (E), 25:59746
  determination in reactor effluent water by ion exchange and γ spectroscopy or radiochemical methods, 25:57351
  exchange between compounds and trisoxinatocobalt(III), 25:57493
COBALT ISOTOPES Co-60
  availability for use as heat source, 25:57654(R) (DP-1279)
  content in Columbia River sediments, (E), 25:57561 (TID-25786)
  determination in reactor effluent water by ion exchange and γ spectroscopy or radiochemical methods, 25:57351
  inhalation of cobalt oxide-incorporated, biological half-life and radiation dose in man following, 25:57995 (CONF-711013-1)
  radiation field from source of, in irradiation facility, measurements of, 25:57631
  reactions of recoil, in neutron-irradiated trisoxinatocobalt, 25:57493
  removal from skin, effectiveness of DTPA, EDTA, and polycomplexon for, 25:57982
  use as tracer in measuring erosion of high-pressure pipe fittings, 25:57662
COBALT OXIDES
  inhalation of cobalt-60-labeled, biological half-life and radiation dose in man following, 25:57995 (CONF-711013-1)
  Al_2O_3--CoO, preparation for high-temperature neutron dosimetry, 25:57723 (CONF-711002-, pp 82-5)
  MgO--CoO, preparation for high-temperature neutron dosimetry, 25:57723 (CONF-711002-, pp 82-5)
COINCIDENCE CIRCUITS
  design of two-fold, with subnanosecond outputs, 25:57786
COLCHICINE
  effects on mitotic activity of cultured cancer cells following γ irradiation, 25:58080
COLLIMATORS
  design and performance for scintigraphy with low-energy radioisotopes, 25:57891
COLLISION PROCESSES
  theory of high-energy atomic, review, 25:58775
COLUMBIA RIVER
  radioisotope content in waters of, effects of chemical, mineral, and physical characteristics of streambed sediments on, (E), 25:57561 (TID-25786)
COMETS
  hydrogen occurrence surrounding, Ogo-5 observations of, (E), 25:58574
  solar-wind effects on tails of, (E), 25:58581
COMPOSITE MATERIALS
  preparation of metal--matrix, methods for, 25:58363
COMPTON EFFECT
  cross section for second harmonic generation in, for partially coherent radiation, (T), 25:59225
COMPUTATIONAL MODULAR SYSTEMS
  description for compressed storage of data from multiparameter experiments, 25:59667
COMPUTER PROGRAMS
  CODINETE 25, for thermal neutron diffusion length in moderators, FORTRAN 2, 25:60226 (LFEN-NI.-60-a)
  COLAPS, for group-averaged discrete-ordinate neutron cross section tables, in FORTRAN for CDC 6600, 25:59843 (SC-DR-710320)
  development for dose calculations for high-energy gamma and x radiotherapy, 25:58008
  development for dose calculations for high-energy electron therapy, 25:58009
  development for dosimetry in high-energy gamma and x radiation therapy, 25:58020
  development for dosimetry in high-energy gamma and x radiation therapy, 25:58021
  development for studies on radioisotope transport kinetics in ecosystems, 25:57947 (CONF-710501-35)
  EDIT, for group-averaged discrete-ordinate neutron and gamma cross section tables, in FORTRAN for CDC 6600, 25:59843 (SC-DR-710320)
  ELRAFT, for calculation of secondary events in fault tree analysis of power reactor accidents, FORTRAN for CDC 6600, 25:60134
  FGCD, for storage and retrieval of Gerber punched card program disks, 25:60287 (SC-M-710408)
  FLINA, for stable and transient flow characteristics of boiling sodium in liquid metal cooled reactors, 25:60112 (CEA-CONF-1797)
  for evaluating high-order vertex parts in perturbation theory, algorithms for γ-algebra of electromagnetic form factors for, 25:59360
  for laboratory quality control, FORTRAN IV for IBM 360, 25:57611 (CTC-51)
  ISIS, for analysis of experimental fission data, 25:59773 (AD-721481)
  listing of nuclear accident analysis, 25:60127
  MODIFY, for group-averaged discrete-ordinate cross section tables, in FORTRAN for CDC 6600, 25:59843 (SC-DR-710320)
  ORRIBLE, for flow and temperature distribution in LMFBR fuel rod bundles, FORTRAN, 25:60062 (ORNL-TM-3516)
  RFSP, for determination of neutron spectra from activation data, 25:57725 (KFKI-71-22)
  RIVA, for double differential cross sections, scattering matrix, and integrated cross sections for neutron scattering by heavy water, in FORTRAN, 25:59671 (IFA-DNBR-3)
  SASSI, for calculation of neutron scattering from spherical optical potential, in FORTRAN IV for IBM 360,

25:59842 (RT/FI-(71)6)
  STP-1, for calculation of fission product production in coolant sodium, 25:58163(R) (AI-AEC-12859)
  THERMOS-MUG, for thermal neutron physics constants for reactors, 25:60225 (JAERI-Memo-4394)
  TOFA, for torsional frequency analysis, in FORTRAN for CDC 6600, 25:60057 (AECL-3994)
  TRUMP, for analysis of temperature distribution in three dimensions, 25:60260 (AECL-3783(Rev.1))
  WIGL2, for solution of one-dimensional two-group space-time diffusion equations, self-initializing version of, 25:60209 (DUN-7538)
COMPUTERS
  development at Chicago Univ, 25:60270(R) (COO-2094-7)
  development at Chicago Univ, 25:60271(R) (COO-2094-8)
  interfacing to CAMAC systems, characteristics of, 25:57885
  use of hybrid, for real time reactor simulation, 25:60218
  uses in automation of chemistry laboratories, 25:60293 (UCRL-72001)
CONCRETES
  deformation and ultimate strength of prestressed, under triaxial stress, 25:58415 (FRNC-TH-61)
  density measurements during vibrocompaction, radiometric densimeter for, 25:57869
  radioactivation of shielding, at JINR synchrocyclotron, 25:59657
CONNECTICUT YANKEE POWER REACTOR
  contol system for, design modifications of, 25:59899
  instrumentation for, design modifications of, 25:59899
CONTAMINATION
  monitoring environmental trace-gas, use of microwave rotational spectroscopy in, 25:60294 (UCRL-73197)
CONTROL SYSTEMS
  comparison of manual and visual, 25:60288 (SC-RR-710502)
  design characteristics for gas flow, for use with gas turbines, 25:60073(P)
  development of computer, for operating wood impregnating and irradiating facility, 25:57628
COPPER
  adhesion to (111) crystal surface of nickel, LEED study on, 25:58270
  bonding to lead telluride, methods for solid-state, 25:58207
  determination by extraction using quinolinol melt and spectrography, 25:57312
  determination in analytical reagents by neutron activation, 25:57379
  determination in fuel solutions of JRR-1, 25:57320
  determination in pure rare earth oxides, polarographic, 25:57311
  determination of trace amounts of, in tungsten trioxide or zirconium dioxide, effects of halide additives on direct spectrographic, 25:57335
  diffusion of bismuth in, beta-excited x-ray studies of, 25:57673
  diffusion of bubbles in thin foils of, effects of dislocations on, 25:58214 (RD/B/N-2023)
  dislocation mobility at 44°K in, 25:60265 (CALT-767-P-3-16)
  effects on recovery of aluminum irradiated with fast neutrons, 25:58303
  electron reactions at 12 to 30 keV with, depth distribution of x-ray production in, (E), 25:58685
  electron reactions at 12.5 to 22 MeV with, bremsstrahlung yield from, 25:59106
  heat transfer from moving spheres of, in subcooled water, studies of film and transition boiling, (E), 25:57642
  helium-ion reactions at 45 to 90 keV/amu with, helium-isotope dependence of cross sections for L-shell ionization in, (E), 25:58776
  mechanical properties of, effects of fatigue on, 25:58223
  microstructure of, effects of fatigue on, 25:58223
  photon reactions at 560 MeV, emulsion study of dependence on atomic weight for yields of π^+ and π^- from, (E), 25:59248
  photon reactions with, secondary electron emission from, (E/T), 25:59107
  preparation of radiation targets of, by argon ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
  radioinduced void formation in, 1-MV electron, (E/T), 25:58327
  radioinduced void formation in, fast neutron, 25:58310
  recovery from sulfide copper ores, use of underground nuclear explosions in, 25:57604 (UCRL-73130)
  separation from plutonium by solvent extraction using TBP, 25:57357
  separation of decontaminated, from nuclearly fractured ores, solvent extraction-electrowinning method for, 25:57523 (ORNL-4677)
  sintering of dendritic and spherical powders of, effects on end-product microstructure, 25:58389(R) (SRO-552-8)
  stability of MSRE salt sampling bucket of, 25:58168 (ORNL-4676, pp 139-233)
  welding to steel, deposition of intermediate layers for, 25:58204
COPPER ALLOYS AND SYSTEMS
  analysis for niobium using magneson, photometric, 25:57315
  preparation of reference specimens of, methods for, 25:58179 (CONF-711002-, pp 47-58)
  radiation damage in, interaction of coherent precipitates with fast-neutron and electron, 25:59163
  Ag-base--Cu--In, bonding to lead telluride, methods for solid-state, 25:58207
  Al--Co--Cu--Fe-base--Ni, properties and structure of, effects of neodymium additions on, 25:58250
  Al--Cu, creep strength of, effects of zirconium additions on, 25:58239
  Al--Cu, welding to steel, deposition of intermediate layers for, 25:58204
  Al--Cu-base, oxidation at high temperatures, mechanisms of, 25:58171
  Al--Cu-base--Si, oxidation at high temperatures, mechanisms of, 25:58171
  AmO_2--Cu, preparation of thin-film radiation sources of, radiofrequency sputtering method for, 25:57651 (CONF-711002-, pp 147-59)
  AmO_2--Cu, sputtering of cermets of, for preparation of thin-film americium oxide radiation sources, 25:57651 (CONF-711002-, pp 147-59)
  Be--Cu-base, oxidation at high temperatures, mechanisms of, 25:58171
  Cu--epoxy resin, radiation effects on strength of joints of, gamma, 25:58416(R) (RLO-2098-2)
  Cu--Ni, welding to steel, deposition of intermediate layers for, 25:58204
  Cu--Si, welding to steel, deposition of intermediate layers for, 25:58204
  Cu--Sn, welding to steel, deposition of intermediate layers for, 25:58204
  Cu--W, crystallization of electron beam-refined composites of, 25:58285
  Cu--Zn, welding to steel, deposition of intermediate layers for, 25:58204
  Cu-base--Si, oxidation at high temperatures, mechanisms of, 25:58171
COPPER IONS
  spectra in x-irradiated alkali metal chlorides, ESR, 25:59201
COPPER ISOTOPES Cu-61
  energy levels from nickel-60 (p,γ) reactions, branching ratios and spin-parity assignments for, (E), 25:59764
COPPER ISOTOPES Cu-63
  helium-3 elastic scattering at 30 MeV, optical-model analysis of differential cross sections for, (E), 25:59769
  proton reactions (p,γ) at 2 to 18 MeV, gamma spectra from, (E), 25:59742
COPPER ORES
  processing of sulfide, using underground nuclear explosions, 25:57604 (UCRL-73130)
COPPER SULFATES
  $CuSO_4$--$FeSO_4$--$Fe_2(SO_4)_3$--$ZnSO_4$, complex ion distribution in aqueous solutions of, 25:57398 (NIM-1093)
CORROSION
  measurement of railroad equipment, use of radioisotopes for, 25:57672
CORROSION LOOPS
  inspection of sodium fluoroborate salt, postoperation, 25:60015 (ORNL-4676, pp 21-72)
  particulate content of sodium in, after 4000 hr operation at 500°C, 25:58170 (RD/B/N-1998)
CORUNDUM
  use in testing abrasion resistance of refractory alloys and materials, 25:58386
COSMIC GAMMA SOURCES
  detection of, performance of large satellite-borne lithium-drifted germanium detectors for, 25:57791
COSMIC PARTICLES
  acceleration of relativistic electron, (T), 25:58830
  beryllium isotopes distribution in, effect of interstellar helium on, 25:59733
  detection and measurement, coupling functions applicable to underground meson telescopes for, 25:58822
  intensity of muons above 3.48 and 7.12 GeV/c, absolute, 25:58826
  intensity variations of primary and secondary muons at high energies, 25:58827
  interactions $\nu + N$ at high energies, μ spectra from, (T), 25:59417
  interactions of cosmic muons at large zenith angles at sea level, 25:59343
  interactions of muons to 1 TeV, cross sections for electromagnetic, 25:59246
  isotope abundance in primary, beryllium, boron, and lithium, (E), 25:58833
  nuclei reactions with light nuclei above 700 MeV/nucleon in emulsions, energy distribution and mean energy of nonrelativistic doubly charged particle production in multicharged, (E), 25:59274
  penetration of parallel groups of, in atmosphere, (E/T), 25:58828
  spectra of 20- to 1000-GeV muons at sea level, 25:59245
  spectra of relativistic electron, (T), 25:58830
COSMIC RADIATION
  effects on interstellar loop structures, (T), 25:58640
  emission during flares from red dwarfs, (T), 25:58443
  gamma background, between 0.7 and 4.5 MeV at balloon altitudes, (E), 25:58832
  gamma flux in, Cosmos-135 measurements of, (E), 25:58835

- intensity of 0.511-MeV gamma line during epoch of meteor streams, (E), 25:58836
- intensity of primary gamma, in vicinity of Earth, (E), 25:58831
- intensity of, rigidity dependence of Forbush decreases and 11-year variations in, (E/T), 25:58823
- intensity variation at 1954 solar minimum, streaming-associated anomalous solar diurnal, (E), 25:58824
- intensity variations of, evaluation of evidence of sidereal time period in, (E/T), 25:58825
- screening of instrumentation in magnetosphere, charge and potential from, (T), 25:59115

COSMIC RADIO SOURCES
- distance to 3C 58, (E), 25:58651
- distribution of, 25:58666
- distribution of extragalactic, (T), 25:58659
- identification of 50, from the Ohio survey, (E), 25:58558
- identification of PKS 1415-24 with AP Lib, (E), 25:58658
- lunar occultation of, (E), 25:58538
- magnetic-field scale in extended extragalactic, (T), 25:58532
- polarization of extended extragalactic, (T), 25:58532
- radiation mechanism for, (T), 25:58526
- radio flux density of Virgo A at 10 to 30 cm, (E), 25:58525
- spectra of compact, at galactic center, (E), 25:58555
- spectra of compact, effects of induced Compton scattering by thermal electrons in, (T), 25:58527
- spectra of, absorption at 21 cm, (E), 25:58651
- spectral analysis of 5C1, (E), 25:58531
- structure in Sgr A, (E), 25:58555
- structure of Sagittarius A, (E/T), 25:58624
- structure of, lunar occultation studies for angular, (T), 25:58529

COSMIC-RAY SPECTROMETERS
- performance of large satellite-borne lithium-drifted germanium, 25:57791

COSMIC RAY TELESCOPES
- coupling functions applicable to underground meson, procedure for primary, 25:58822

COSMIC SHOWERS
- intensity and distribution of muon, underground, 25:59247
- properties of EAS core at 10^{15} eV, (E), 25:59249
- secondary particle distribution in fireball model, double-peaked structure of, 25:59529

COSMIC X-RAY SOURCES
- Cyg X-1, optical identification with HD 226868, (E), 25:58554
- Cyg X-3, model featuring excitation of radial vibrations in white dwarf, (E/T), 25:58552
- Cyg XR-1, eclipsing binary model for, (E), 25:58553
- Cyg XR-2, distance to, (E), 25:58548
- distribution of, (T), 25:58565
- evolution from pulsars in binary systems, (T), 25:58424
- GX 340 + 0, spectrum from 1 to 10 keV, (E), 25:58534
- identification of, (E), 25:58530
- Pup A, spectra of, (E), 25:58561
- Sco X-1, high-frequency oscillations in x-ray flux from, (E), 25:58536
- Sco X-1, short-period oscillation in optical and x-ray flux from, (E), 25:58535
- spectra of Cyg XR-2, soft x-ray, (E), 25:58548
- Vel X, spectra of, (E), 25:58561

COSMOLOGY
- arrow of time in, (T), 25:58672
- big-bang, evidence for, (T), 25:58666
- constant of, (T), 25:58661
- deceleration parameter in, (T), 25:58666
- dissipative processes in early Universe, (T), 25:58669
- evolution and thermodynamic irreversibility, (T), 25:58672
- gravitational constant in, decreasing, (T), 25:58667
- localizability of particles in de Sitter space, (T), 25:58660
- luminosity evolution in, (T), 25:58666
- mass in, nature of, (T), 25:58667
- matter density in, (E/T), 25:58635
- models for, matter effects in, (T), 25:58669
- models for, time scale of expansion in Friedmann, (T), 25:58663
- time asymmetry in, (T), 25:58671

COUNTERCURRENT SEPARATION PROCESSES
- equipment for separation of stable oxygen isotopes from heavy water, design and operation of, 25:57675

CRAB NEBULA
- flux from, 10 μm, (E), 25:58541

CRACKS
- propagation of Griffith, thermodynamic-kinetic model of, 25:58209 (AECL-3992)

CREATININE
- determination in urine, methods used at CNEN for, 25:57347 (RT/PROT-(71)9)

CREEP
- determination of in-reactor, from stress relaxation experiments, 25:58209 (AECL-3992)

CRITICAL ASSEMBLIES
- critical mass of homogeneous water moderated spherical uranium-235, with mixed natural uranium and water reflector, (T), 25:60220
- criticality of water moderated, effects of 20 to 250°C on, 25:60161
- fission products in Core 3000 and Core 4000 of STEK Assembly, reactivity worth measurements for, 25:60159 (RCN-150)
- multiplication factors for hollow cylindrical water moderated highly enriched aluminum--uranium-235, (E/T), 25:60212
- multiplication factors for unmoderated and unreflected, collision probability method calculations of, (E/T), 25:60230
- physics measurements in ZPR, preparation of fissionable foils for, 25:58180 (CONF-711002-, pp 70-6)
- physics measurements in ZPR-6, ZPR-9, and ZPPR, for liquid metal cooled fast reactors, 25:60005(R) (ANL-7854)
- physics parameter measurements in SNEAK and SUAK, comparison of calculations with integral, 25:60036 (EURFNR-945)
- safety analysis of ETRC, reevaluation of initial, (T), 25:60149 (ANCR-1002)

CROSS SECTIONS
- correction for velocity of total scattering, from beam experiments, 25:58757
- data libraries for group-averaged discrete-ordinate, computer programs for, 25:59843 (SC-DR-710320)
- library for charged particle, description of LRL evaluated, (E), 25:59783 (UCRL-50400(Vol.4))
- measurements of, nondestructive and destructive methods of analysis used in fabrication of targets for, 25:57345 (CONF-711002-, pp 293-306)

CRYSTAL RIVER POWER REACTOR, UNIT 3
- construction of, request for not suspending permit for, 25:59969 (DOCKET-50302-26)

CRYSTALS
- atom locations in, channeling-effect technique for study of, 25:59167
- charged-particle dechanneling by lattice defects in, review, 25:59169
- content of nonmetallic, in high-temperature sodium loops, 25:58170 (RD/B/N-1998)
- ion channeling and blocking in, review of, 25:59151
- ion channeling in, review, 25:59165
- ion channeling in, review of principles and applications of, 25:59167
- proton and ion channeling in, calculations of electronic and nuclear stopping powers for, 25:59129
- rare gas release during annealing of ion-bombarded ionic, review of stages of, 25:58412
- surface energy and work function of smooth faces of metallic mono-, (T), 25:59194
- transmission in, scattering of laser beams by electron beams in anomalous, (T), 25:59228

CURIUM
- oxidation potential for trivalent--tetravalent, 25:57437
- separation from americium by electromigration, 25:57520 (JINR-E6-5952)
- separation from americium by ion exchange chromatography on zirconium phosphate, 25:57551
- separation from other actinides by paper or thin-layer chromatography, 25:57553

CURIUM ALLOYS AND SYSTEMS
- Cm--Ir, preparation of intermetallic $CmIr_3$, by oxide reduction reactions, 25:57658(R) (ORNL-4723)
- Cm--Pt, preparation of intermetallic $CmPt_3$, by oxide reduction reactions, 25:57658(R) (ORNL-4723)
- Cm--Rh, preparation of intermetallic $CmRh_3$, by oxide reduction reactions, 25:57658(R) (ORNL-4723)

CURIUM ISOTOPES Cm-244
- production by target irradiation in HFIR and processing in TRU, 25:57524 (ORNL-TM-3343)

CURIUM OXIDES
- compatibility with refractory capsule materials at high temperatures, 25:57658(R) (ORNL-4723)
- fabrication of radioisotope fuels of, use of gadolinium oxide as stand-in for development of methods for, 25:57653 (DP-1270)
- preparation of sized particles of, ion exchange carbonization method for, 25:57658(R) (ORNL-4723)
- thermal capacity of, development of equipment for measuring, 25:57658(R) (ORNL-4723)

CURRENT ALGEBRA
- charge-current commutator in quantum electrodynamics, equal-time, 25:59566
- field algebra, review on, 25:59324
- hyperon (Ω^-) decay in, 25:59398
- PCAC hypothesis from s-wave threshold amplitudes of $\gamma + N \to \pi^0 + N$ interactions, (E/T), 25:59373
- review on developments in, 25:59323

CYANOGEN
- abundance in delta Scu, (E), 25:58479
- abundance in sunspots, (E/T), 25:58589

CYCLOHEXANE
- radiolysis of, kinetics of, 25:57473

CYCLOPHOSPHAMIDE
- effects on incidence of cleft palate and oligodactylia in mouse embryos following in utero exposure, 25:58127

CYCLOPROPANE
- radiolysis of clathrate hydrates of, stability of radicals from γ, 25:57476

CYCLOTRON RADIATION
- emission from nonequilibrium plasma, effects of spatial

XUM

dispersion on, (T), 25:59097

CYCLOTRONS
  beam extraction system for ORNL 86-inch, failure of aluminum tubing in, 25:59643 (ORNL-TM-3523)
  experimental facilities at Texas A and M, description of on-line programmable data acquisition interface for, 25:59665

CYSTAMINE
  effects on redox potential in muscles of dogs, mice, and rats following injection, correlation between dose and, 25:58031
  radioprotective effects on dogs, mice, and rats, correlation between effects on muscle redox potential and, 25:58031

CYSTEINE
  radioprotective effects against chlorophyll mutations in barley, x, 25:57974

CYTOCHROME C
  Moessbauer spectroscopy of, 25:60279(R) (NYO-3798-12)

CYTOPLASM
  radiation effects on cultured human cell, following microbeam exposure in relation to incidence of interphasic death, uv, 25:58084
  radiosensitivity effects of structure of HeLa and melanoma cell, electron microscopy of x, 25:58085

D

DACTINOMYCIN
  effects on DNA and RNA stability and synthesis and on growth in gamma-irradiated Tetrahymena pyriformis, effects of concentration on, 25:58091

DATA ACQUISITION SYSTEMS
  description of CAMAC, 25:57883
  description of CAMAC Branch Highway, 25:57881
  description of computer-controlled CAMAC, for low-energy nuclear physics at ANL, 25:57884
  description of fast single-ADC, for pulse height analysis, 25:59668
  description of fully automatic, for photonuclear cross sections, 25:59772
  description of Sandia time-shared on-line, for radiation research, 25:59666
  design and performance of high-count rate two-parameter, for gamma spectra of neutron capture resonances, 25:57806
  development for ORNL fusion experiments, 25:59075 (ORNL-TM-3593)
  development of reactor protection system, 25:60208
  interfacing of CAMAC, to small computers, 25:57885
  operation of CAMAC Branch Highway and Dataway, signal standards for, 25:57880
  operation of CAMAC Dataway, standards for control language for, 25:57882
  performance of computerized automatic, in nuclear materials safeguards system, 25:57704 (GULF-RT-A-10826)
  status of CAMAC, November 1970, 25:57888

DATA DISPLAY SYSTEMS
  description of Sandia time-shared on-line, for radiation research, 25:59666

DATA PROCESSING SYSTEMS
  development of reactor protection system, 25:60208

DAVIS-BESSE POWER REACTOR
  construction of, request for not suspending permit for, 25:59987 (DOCKET-50346-20)

DECONTAMINATION
  equipment for biological, chemical, and radioactive, of objects and persons, design and operation of motor vehicle, 25:57622(P)
  equipment for footwear worn in nuclear facilities, design and operation of ultrasonic, 25:57629
  methods for process equipment from radiochemical separations plants, 25:57517 (DP-1266)
  procedures for power reactor component maintenance and replacement, 25:60099
  requirements for power reactor component maintenance and replacement, 25:60099

DENSIMETERS
  design of beta radiometric, for measuring dust collected on filters, 25:57870
  design of gamma radiometric, for selecting head lettuce for harvesting, 25:57871(P)
  design of radiometric, for flowing powders in reservoir, 25:57872(P)
  design of radiometric, for studying vibrocompacting of concretes, 25:57869
  use of photo-, in assay of materials used in nuclear measurements, 25:59640 (CONF-711002-, pp 272-82)

DETONATION WAVES
  propagation in plasma, relativistic theory for, 25:59043

DEUTERIUM
  carbon-ion (C^-) reactions with molecular, effects of thermal motion of molecules on charge exchange in, (T), 25:58752
  determination by combustion in stream of hydrogen, oxidation, and ir spectrometry, 25:57349
  deuterium-hydride scattering by molecular, velocity dependence of total effective cross sections for, 25:58782
  deuterium-molecule scattering by molecular, velocity dependence of total effective cross sections for, 25:58782
  deuteron reactions (d,dp) at 20.7 MeV, DWBA and PWBA analyses of coincidence cross sections for, (E/T), 25:59699
  deuteron reactions (d,n) and (d,p) at 10 and 11.5 MeV, analyzing powers for, (E), 25:59700
  effects on carcinogenicity of 7,12-dimethylbenz [a]-anthracene in mice, 25:57920
  effects on ferroelectric properties of potassium acid phosphate crystals, (T), 25:59196
  effects on fractionation factors for lyonium and lyate ions in methanol, 25:57427
  effects on ir spectra of acetylene, 25:57433
  effects on ir spectra of hydrogen cyanide, 25:57421
  effects on isotopic exchange between ethane and hydrogen on nickel catalyst, 25:57428
  effects on mandelaldehyde--2-hydroxyacetophenone isomerization, 25:57431
  effects on PMR spectra of divalent beryllium in aqueous solutions, 25:57429
  effects on reaction between galvinoxyl and trihydrogalvinoxyl in cyclohexane, 25:57432
  effects on rotational constants for hydrogen cyanide, 25:57423
  effects on rotational spectra of ammonia in 0.5-mm wavelength region, 25:57424
  effects on self-diffusion of methane and diffusion of methane in argon and neon, 25:57434
  effects on vibrational spectra of chloroethane, 25:57422
  helium-3 reactions (He-3,tp) and (He-3,He-3p) at 27 MeV, PWBA analysis of coincidence spectra from, (E/T), 25:59694
  helium-atom scattering by molecular, velocity dependence of total effective cross sections for, 25:58782
  Lamb shift of, 25:58813
  neutron capture at 0.025 eV, cross sections for two-quantum radiative, (T), 25:59527
  neutron elastic scattering by, dispersion relations for unphysical cuts in nuclear structure studies of, (T), 25:59691 (LA-DC-12958)
  nuclear magnetic resonance in solid and liquid, relaxations in pulsed, (E/T), 25:59202
  photon scattering by, analysis for double scattering and glory effects in Compton, (T), 25:59703
  reactions with hydrogen molecules of atomic, differential cross sections for deuterium hydride formation in, (E), 25:58778
  reactions with sodium (3^2P) atoms of molecular, cross sections for excitation in, (E), 25:58778
  scattering by molecules of molecular, velocity dependence of total effective cross sections for, 25:58782
  separation from hydrogen on cathode and diffusion sides of palladium--silver foils, factors for, 25:57538

DEUTERIUM HYDRIDES
  deuterium-hydride scattering by, velocity dependence of total effective cross sections for, 25:58782
  deuterium-molecule scattering by, velocity dependence of total effective cross sections for, 25:58782
  helium-atom scattering by, velocity dependence of total effective cross sections for, 25:58782
  scattering by molecules, velocity dependence of total effective cross sections for, 25:58782
  scattering by rare gases at 300 to 3500 m/sec, total effective cross sections for, (E), 25:58781

DEUTERIUM SYSTEMS
  D--Nb--Ti, deuterium distribution fluctuations in $NbTi_2D$, 25:58278
  D--T, laser heating of plasma of, (T), 25:58965

DEUTERONS
  binding energy from dispersion relations for mass--energy form factors, 25:59526
  binding energy of singlet-state, 25:59518
  binding energy of, separable potentials for, (T), 25:59517
  effects on metal foils at MeV ranges, design of low-temperature facility for studies of, 25:57620 (RISO-204)
  form factors for $e + d \to e + d$ interactions, effect of $\Delta(1236) - \Delta(1236)$ configuration admixtures on, (T), 25:59367
  form factors of, vector mesonic correction to electromagnetic, 25:59379
  interactions anti d + d 13.3 GeV/c, total cross sections for, (E), 25:59275
  interactions anti n + d, total cross sections for, (E), 25:59275
  interactions anti $p + d \to p + \pi^+ + 2\pi^- + \pi^0$ at 5.5 GeV/c in deuterium bubble chamber, cross sections for anti $p + n \to \pi^+ + 2\pi^- + \pi^0$ interactions, rate for single rho production, upper limit for double rho production, cross sections, and angular and momentum distributions in, (E), 25:59276
  interactions anti p + d at 6.65 GeV/c, CPT invariance test from ratio of total cross sections of anti d + p interactions at 13.3 GeV/c to total cross sections of, (E), 25:59275
  interactions $d + n \to (nn) + p$ at 2 to 160 MeV, three-body separable potential for, 25:59510
  interactions $d + p \to (np) + p$ at 2 to 160 MeV, three-body separable potential for, 25:59510

- interactions $d + p \to (pp) + n$ at 2 to 160 MeV, three-body separable potential for, 25:59510
- interactions $d + p \to p + d$ at 2 to 160 MeV, three-body separable potential for, 25:59510
- interactions $e + d \to e + d$, effect of $\Delta(1236) - \Delta(1236)$ configuration admixtures on deuteron form factors for, (T), 25:59367
- interactions $e + d$, Tamagaki and Hamada--Johnston potentials for elastic, 25:59335
- interactions $\gamma + d \to \mathrm{eta} + d$, amplitudes with anomalous thresholds for ω exchange and S_{11} contributions to, (T), 25:59514
- interactions $K^- + d \to K^- + d$ at 810 to 1110 MeV/c, angular distributions for, (E), 25:59302
- interactions $K^- + d \to K^- + p + n$ at 810 to 1110 MeV/c, angular distributions for, (E), 25:59302
- interactions $K^- + d \to K^- + \pi^- + 2p$ at 12.6 GeV/c, production of $p\pi^-(1450)$ enhancement, cross sections for $K + \pi \to K + \pi$ interactions, production cross sections for Ξ^- and Ω^-, and cross sections for, (E), 25:59283
- interactions $K^- + d \to K^- + \pi^+ + \pi^- + n + p$ at 12.6 GeV/c, production of $n\pi^+\pi^-(1450)$ and $p\pi^+\pi^-(1450)$ enhancements, production cross sections for Ω^- and Ξ^-, and cross sections for, (E), 25:59283
- interactions $K^- + d \to \pi^- + \Lambda + p$, Λp mass spectra in, 25:59522
- interactions $n + d$, calculation of doublet scattering length using rank-four separable potential, (T), 25:59707
- interactions of, comparison of models for relation of amplitude for nucleon production in nucleon interactions with amplitude for deuteron production in, (T), 25:59514
- interactions $p + d \to p + d$ at 70 GeV, emulsion study of differential cross sections and slope parameters for, (E), 25:59273
- interactions $p + d$ at 12.8 GeV/c, Glauber multiple scattering model for elastic, (E/T), 25:59269
- interactions $\pi^+ + d \to d + \pi^+ + \pi^+ + \pi^-$ at 13 GeV/c, dual diffractive model for, (E/T), 25:59480
- interactions $\pi^+ + d \to p + p + \pi^+ + \pi^-$ at 7 GeV/c, production of $g^0(1670)$ in, (E), 25:59288
- interactions $\pi^+ + d \to$ p/sub s/ $+ p + \pi^+ + \pi^- + \pi^0$ at 7.0 GeV/c, production and decay of N*(1500) and N*(1700) in, 25:59307
- interactions $\pi^+ + d \to \pi^+ + d$ at 40 and 60 MeV, use of impulse approximation for calculation of differential cross sections for, (E), 25:59484
- interactions $\pi^+ + d \to \pi^+ + n + p$ at 40 and 60 MeV, use of impulse approximation for calculation of differential cross sections for, (E), 25:59484
- interactions $\pi^+ + d$ at 2.7 and 3.1 GeV/c in bubble chamber, resonance production in five- and six-charged-particle final states in, (E), 25:59282
- interactions $\pi^- + d$ at 9 GeV/c, Glauber multiple scattering model for elastic, (E/T), 25:59269
- reactions (d,α) with beryllium-9 at 0.9 to 2.2 MeV, differential cross sections and excitation functions for, (E), 25:59721
- reactions (d,α) with beryllium-9 at 120 to 200 keV, energy levels of boron-11 from, (E), 25:59827 (CEA-R-4070)
- reactions (d,α) with lithium-6 at 400 to 960 keV using polarized beam, analyzing power for, (E), 25:59737
- reactions (d,dp) with deuterium at 20.7 MeV, DWBA and PWBA analyses of coincidence cross sections for, (E/T), 25:59699
- reactions (d,He-3) with neon-20, coupled-channel analysis for inelastic effects in, (T), 25:59758
- reactions (d,n) and (d,p) with deuterium at 10 and 11.5 MeV, analyzing powers for, (E), 25:59700
- reactions (d,n) with helium-3, formalism for polarized particles in, (T), 25:59837 (LA-4492)
- reactions (d,n) with tritium at 0.2 to 1 MeV using polarized beam, analyzing power for, (E), 25:59705
- reactions (d,n) with tritium at 0.5 to 7 MeV, compound-nucleus analysis of differential and total cross sections and neutron polarization from, (T), 25:59706
- reactions (d,n) with tritium, formalism for polarized particles in, (T), 25:59837 (LA-4492)
- reactions (d,p) and (d,t) with beryllium-9 at 120 to 200 keV, angular distributions and mechanisms for, (E/T), 25:59827 (CEA-R-4070)
- reactions (d,p) with beryllium-9 at 2 to 10 MeV, distorted-wave analysis of proton polarization in, (T), 25:59722
- reactions (d,p) with calcium-40 at 70 to 12 MeV, DWBA and impulse-approximation analyses of, (T), 25:59848
- reactions (d,p) with calcium-40, effects of deuteron D state on, (T), 25:59841(R) (ORO-4119-1)
- reactions (d,p) with carbon-12 at 80.2 MeV, DWBA analysis of differential cross sections for, (E), 25:59754
- reactions in lead at 0.85 to 1.7 GeV/c, neutron yield from, (E), 25:59820
- reactions with nuclei, DWBA treatment of finite-range effects in calculation of differential cross sections for stripping, (T), 25:59854
- scattering by gold layers on vanadium, measurement of layer thickness by, 25:59640 (CONF-711002-, pp 272-82)
- scattering by nuclei at 80 MeV, optical-model analysis of angular distributions from elastic, (E), 25:59754
- scattering by nuclei at 82 MeV, DWBA analysis of angular distributions from inelastic, (E), 25:59754

- DEUTERONS (anti d)
  - interactions anti d + d 13.3 GeV/c, total cross sections for, (E), 25:59275
  - interactions anti d + p at 13.3 GeV/c, CPT invariance test from ratio of total cross sections of anti p + d interactions at 6.65 GeV/c to total cross sections of, (E), 25:59275
- DEXTRAN
  - radiosterilization of powders of, chemical and physical changes induced in γ, 25:58160
- DIABLO CANYON POWER REACTOR, UNIT 2
  - construction of, request for not suspending permit for, 25:59958 (DOCKET-50275-16)
- DIAMONDS
  - radioinduced defects in, review of, 25:59137
  - use in testing abrasion resistance of refractory alloys and materials, 25:58386
- DIET
  - radioisotope content of human, in EURATOM countries during 1969, 25:57979 (EUR-4667)
- DIFFERENTIAL EQUATIONS
  - resolution of hierarchy of Green function for fermions, 25:59218
  - solution of partial, using symbolic style of Algol, 25:59216
- DIFFUSION
  - measurement in solids by beta excitation of x rays, 25:57673
  - short-circuiting effects in solids, 25:58209 (AECL-3992)
- 1,3-DIOXOLANE
  - radiolysis of hydrates of, EPR studies on free radicals from γ, 25:57465
- DISEASES, INFECTIOUS
  - tinea capitis, radiotherapy in children, use of Fricke dosimeter to measure absorbed x-ray dose to brain during, 25:58012
  - vaccinia, radioinduced lesions in mouse and rat, similarity between normal and, 25:58128
- DISEASES, NEOPLASTIC
  - adenomas, radiotherapy of human thyroid, use of iodine-131 for post-surgical interstitial, 25:58056
  - cancer, radiotherapy of human cervical, effects of adrenal cortex extract on, 25:58035
  - carcinomas, radioinduced squamous cell, in rat tibia, comparison of γ and x, 25:58102
  - carcinomas, radiotherapy of human gynecological, effects of dose on injuries to bladder and rectum during contact cobalt-60 γ, 25:58010
  - carcinomas, radiotherapy of human skin, effectiveness of x, 25:58068
  - carcinomas, radiotherapy of human thyroid, using interstitial iodine-131, possibility of contamination of environment, 25:58079
  - carcinomas, radiotherapy of human, role of antitumor immune mechanisms of normal tissues in, 25:58072
  - carcinomas, radiotherapy of pulmonary, review of complications and effectiveness in cobalt-60 γ and sieve and super-high voltage x, 25:58137
  - carcinomas, radiotherapy of uterine cervical, effectiveness of intracavitary radium, super-high voltage x, and telecobalt γ, 25:58070
  - conference on intestinal, 25:58029
  - diagnosis of human liver, comparison of effectiveness of angiography, radioisotope scanning, and ultrasound tomography for, 25:58044
  - malignant, radiotherapy of human breast, survival rate following post-surgical γ, 25:58071
  - malignant, radiotherapy of human breast, survival rate following pre-surgical gamma and x, 25:58073
  - malignant, radiotherapy of human gynecologic, occurrence of vesicovaginal fistula following, 25:58135
  - malignant, radiotherapy of human, effectiveness of high-energy electron and x, 25:58076
  - melanomas, radiodiagnosis of human eye, phosphorus-32 uptake test for, 25:58063
  - melanomas, radiodiagnosis of human eye, using phosphorus-32 uptake and semiconductor detectors, 25:58064
  - myelomas, radioinduced heterotopic bone formation in lungs of man with, x, 25:58133
  - osteosarcomas, growth dynamics of radioinduced, in beagle dogs following injection of plutonium-239, radium isotopes, strontium-90, and thorium-228, 25:57918
  - radiodiagnosis in human lungs, evaluation of scintigraphic methods for, 25:58040 (UCLA-12-834)
  - radioinduction in rats, effects of age and sex on whole-body x, 25:58097(T) (ORNL-tr-2521)
  - radiotherapy of human, hazards to normal tissues from combined antineoplastic drug therapy and supervoltage, 25:58077
  - sarcomas, radiation effects on growth of transplanted mouse, effects of dose on electron and x, 25:58083
  - sarcomas, radiation effects on phospholipase A activity in dog Sticker, γ, 25:57940
  - sarcomas, radioinduced osteogenic, osteoplastic, and spindle cell, in rat tibia, comparison of γ and x, 25:58102
  - scintigraphy of human liver, using gallium-67, 25:58045
  - tumors, radiation effects on cell division in epidermis of human mammary, x, 25:58146
  - tumors, radiotherapy of human brain, effectiveness of γ,

XUM

25:58069
  tumors, radiotherapy of human cervical, cytology and histology of epithelium following γ, radium, and x, 25:58140
  tumors, radiotherapy of human dose distribution planning for megavolt, 25:58007
  tumors, radiotherapy of remnants of human cervix uteri, following external γ or x radiotherapy, effectiveness of small radiation sources for, 25:58074
DISEASES, PHYSIOLOGICAL
  deoxycitidinuria, incidence among uranium mining personnel, role of age in, 25:58145
  Fanconi's anemia, effects on frequency of γ radioinduced chromosome aberrations in children, 25:57973
  hyperthyroidism, radiotherapy of human, using interstitial iodine-131, possibility of contamination of environment through, 25:58079
  radiodiagnosis in human lungs, evaluation of scintigraphic methods for, 25:58040 (UCLA-12-834)
DISEASES, TRAUMATIC
  radiation injuries, evaluation of biochemical indicators of, 25:58126
  radiation injuries, treatment of, induced in human skin following therapy, 25:58038
  radiation sickness, cardiovascular changes in laboratory animals during, 25:58122
  radiation sickness, radiation effects on sensitivity of man to pharmaceuticals for treatment of, 25:58142
  radioinduced dermatitis, effectiveness of topical 5-fluorouracil for treatment of human, 25:58037
  shock, effects of sublethal hemorrhagic, on survival of mice following subsequent whole-body irradiation, 25:58109
  wounds, monitoring for plutonium, design of collimated alpha detector for, 25:57998 (NIRS-Pu-8)
DISPERSE SYSTEMS
  dynamic behavior of inhomogeneous, (T), 25:58380
DISPERSION RELATIONS
  meson (π) production in $\gamma + N \to \pi + N$ interactions, vector meson dominance for invariant amplitudes of, 25:59351
  review on, 25:59425
  test of forward, review on experimental, 25:59424
DOGS
  radiation effects on neurosecretory cells in hypothalamus of, acute whole-body x, 25:58129
  radioinduced osteosarcoma growth dynamics in beagle, following injection of plutonium-239, radium isotopes, strontium-90, and thorium-228, 25:57918
  redox potential in muscles of, effects of cystamine on, 25:58031
  tritium oxide toxic effects on, 25:57916
DONALD C. COOK POWER REACTOR, UNIT 1
  containment system for, requested additional data on, 25:59972 (DOCKET-50315-48)
  containment systems for, performance evaluation of, 25:59973 (DOCKET-50315-49)
  cooling system for, requested additional data on, 25:59972 (DOCKET-50315-48)
  radioactive waste disposal system for, revised and additional data on, 25:59972 (DOCKET-50315-48)
DONALD C. COOK POWER REACTOR, UNIT 2
  containment system for, requested additional data on, 25:59972 (DOCKET-50315-48)
  containment systems for, performance evaluation of, 25:59973 (DOCKET-50315-49)
  cooling system for, requested additional data on, 25:59972 (DOCKET-50315-48)
  radioactive waste disposal system for, revised and additional data on, 25:59972 (DOCKET-50315-48)
DOUNREAY FAST REACTOR
  cooling system for, failure location and repair in primary, 25:60078
DRESDEN POWER REACTOR, UNIT 1
  emergency core cooling system for, performance evaluation of, 25:59935 (DOCKET-50010-96)
DRESDEN POWER REACTOR, UNIT 2
  control system for, maintenance requirements for unplanned shutdown from spurious signal in pressure of, 25:59917
  fuel elements for, performance evaluation of, 25:59941 (DOCKET-50237-203)
DRESDEN POWER REACTOR, UNIT 3
  operation of, request for not suspending license for, 25:59947 (DOCKET-50249-105)
DRUGS
  analysis for iodine by radioisotope x-ray fluorescence, use of Ross filters in, 25:57322
DUANE ARNOLD POWER REACTOR
  construction of, request for not suspending permit for, 25:59979 (DOCKET-50331-28)
DUSTS
  mass of, collected on filters, beta radiometric gage for measuring, 25:57870
  radioactivity of the Netherlands atmospheric, during 1967, gross α, β, γ, 25:57575 (RA-42)
DYES
  radiation effects on decoloration of textile, synergistic effects of oxidants on γ, 25:57452
  radiosensitizing effects on nerve fibers, uv, 25:57942
DYSPROSIUM
  complexes with HEDTA, dissociation constants for, 25:57537
  determination in fluorite by solvent extraction and spectrography or fluorimetry, 25:57332
  determination in silicate rocks by neutron activation, low-energy photon detector for, 25:57387
  energy levels of, identification of 4f/sup N-1/$6s^2$6p configurations in, 25:58706
  optical properties at 1.13 to 3.96 eV, 25:59187
  oxidation potential for trivalent--tetravalent, 25:57437
DYSPROSIUM ALLOYS AND SYSTEMS
  Dy--Ho, phase studies of, 25:58274
  Dy--Ho--Y, phase studies of, 25:58274
DYSPROSIUM IONS
  wave functions for Dy^{2+}, analytical self-consistent-field calculations of, 25:58698
DYSPROSIUM ISOTOPES Dy-160
  energy-level transitions in, sign of amplitude mixing ratio for, (E), 25:59819
  neutron reactions (n,α) at 14.2 MeV, presence of direct effects in spectra from, (E/T), 25:59802
DYSPROSIUM ISOTOPES Dy-161
  neutron reactions (n,α) at 14.2 MeV, presence of direct effects in spectra from, (E/T), 25:59802
DYSPROSIUM ISOTOPES Dy-163
  neutron reactions (n,α) at 14.2 MeV, presence of direct effects in spectra from, (E/T), 25:59802
  preparation of monocrystalline, by grain growth annealing, 25:58184 (CONF-711002-, pp 181-90)
DYSPROSIUM ISOTOPES Dy-164
  neutron reactions (n,α) at 14.2 MeV, presence of direct effects in spectra from, (E/T), 25:59802
DYSPROSIUM OXIDES
  reduction to metal using thorium with simultaneous distillation separation, 25:58184 (CONF-711002-, pp 181-90)

E

EARTH
  electric currents in, correlation with geomagnetic-field daily, lunar, and disturbance variations, (E/T), 25:58889
  temperature changes due to fusion energy in years 2000 to 2020, 25:58956
EARTHQUAKES
  discrimination between underground nuclear explosions and, using seismic P-wave spectra, 25:57599
  discrimination between underground nuclear explosions and, using short period seismic array data, 25:57600
  effects on BWR-type nuclear power plants, models for simulating dynamic, (T), 25:57598
  occurrence in Amchitka Island region, effects of Milrow Event on, 25:57597
  occurrence near Nevada Test Site during 1950 to 1971, (E), 25:57589 (CGS-746-12)
ECHINODERMATA
  Asterine gibbosa, radiosensitivity of hermaphrodite gonads of, studies on differential x, 25:58090
ECOSYSTEMS
  contamination by DDT, mathematical analysis of probability under various conditions, 25:60262 (BNWL-SA-3977(Rev.))
  radioisotope transport through, use of biological models and computer calculations for measurements of kinetics of, 25:57947 (CONF-710501-35)
EDDY CURRENT TESTING
  method for electrically-conducting tubes and reactor fuel rods, 25:57692(P)
  method for welded joints in reactors, 25:57680 (ORNL-TM-3561)
  probe for coating crack detection in Rover fuel elements, design of masked, 25:57659
EDWIN I. HATCH POWER REACTOR, UNIT 1
  construction of, request for not suspending permit for, 25:59976 (DOCKET-50321-24)
EDWIN I. HATCH POWER REACTOR, UNIT 2
  design parameters of, revised and additional data on, 25:59992 (DOCKET-50366-16)
  design parameters of, revised and additional data on, 25:59993 (DOCKET-50366-17)
  operations aspects of, revised and additional data on, 25:59992 (DOCKET-50366-16)
  operations aspects of, revised and additional data on, 25:59993 (DOCKET-50366-17)
EINSTEINIUM
  oxidation potential for trivalent--tetravalent, 25:57437
EINSTEINIUM ISOTOPES Es-253
  production by target irradiation in HFIR and processing in TRU, 25:57524 (ORNL-TM-3343)
ELECTRIC ARCS
  design of wall-stabilized argon, for vacuum uv spectroscopy, 25:59006
  gas heating by stabilized, at high pressures, calculation of characteristics of, 25:59059
  plasma diagnostics in free-burning, spectroscopic, (E/T), 25:58958
  properties in strong magnetic fields, (E/T), 25:59005
  use of spark gap, for laser beam pulsing, 25:59076(T) (UCRL-Trans-10556)

ELECTRIC CONDUCTIVITY
- measurement and numerical analysis of, from 4 to 300°K, 25:58929 (FRNC-TH-72)
- temperature coefficient of, dynamic method for measurement cf, 25:58241

ELECTRIC CONDUCTORS
- design of superconducting, 25:58954(P)
- design of, including superconducting material, 25:58953(P)

ELECTRIC CURRENTS
- measurement of subpicoampere to microampere, design of MOSFET current-to-frequency converter for, 25:57894

ELECTRIC DISCHARGE
- book: Plasma Physics and Problems of Controlled Thermonuclear Synthesis, 25:58957
- cathode sheath in disturbed magnetoplasma, (T), 25:59035
- conference on gas discharges, international, London, 9/70, 25:59009
- electron avalanches in hydrogen, losses from, 25:59010
- electron energy balance equation for positive column, self magnetic fields in, (T), 25:59038
- potential breakdown in low-pressure hydrogen, (E), 25:59022
- potential breakdown in, computer simulation of, (E/T), 25:59004
- properties cf high-current, in alkali-metal-seeded rare gases, 25:59023
- wave interactions in, ion acoustic and ionization, (E/T), 25:59098

ELECTRIC POWER
- operation of systems of, effect of magnetic storms cn, (E/T), 25:58887
- production in UK, forecasts to year 2000, 25:57633
- transmission systems for, development of underground, 25:60109

ELECTRIC PROBES
- design of masked eddy current, for detection of coating cracks in Rover fuel elements, engineering drawings for, 25:57659
- performance for plasma potential measurements, (E), 25:58992
- performance for turbulent plasma diagnostics, probe geometry effects on, (E), 25:58983
- performance of double, effect of electron and ion drifts on, (T), 25:58981
- performance of hot and cold, for plasma diagnostics, (E), 25:58986
- properties cf cylindrical Langmuir, in low-density plasmas, 25:58999
- theory of cooled spherical electrostatic, in continuum gas, 25:58982
- use of double microfield, for plasma diagnostics, (E), 25:58990

ELECTRODYNAMICS
- electric field strength in, effects of upper limit on electron energy eigenvalues and wave functions in superheavy nuclei, (T), 25:59554
- time asymmetry in, (T), 25:58671

ELECTROJETS
- effects of auroral, cn heating of thermospheric winds, (T), 25:58864
- electron drift in equatorial, effect of magnetic activity cn, (E/T), 25:58905
- electrostatic plasma instabilities in equatorial, (E/T), 25:58900
- intensity in auroral bounderies, relation to visual aurorae occurrence, (E), 25:58857
- mechanism of auroral, description of electric-discharge, (E/T), 25:58909

ELECTROLYTIC CELLS
- design of mercury cathode, for stable working potential, 25:60295(T) (UCRL-Trans-10548)
- design of quartz, for studies of sulfur compounds, 25:58387(R) (ANL-7823)

ELECTROMAGNETIC FIELDS
- charged-particle radiative polarization in, with two waves traveling toward each other, (T), 25:59226
- interactions $\gamma + e \to \gamma\ (2\gamma) + e$ in constant, spectral and angular distributions for Compton and induced Compton, (T), 25:59368
- mesons in, gauge-invariant Lagrangian for massive vector, (T), 25:59555
- plasma motion in hf, nonlinear theory of, 25:59037
- radiation scattering in linearized Einstein--Maxwell, (T), 25:59606
- theory for system of gravitational field, massless scalar field and, solutions in, (T), 25:59587
- theory for, prcjective solution of integral equations for, 25:59214
- wave functions for, reduction in free space of, 25:59347

ELECTROMAGNETIC LENSES
- design of quadrupole, as low-resolution spectrometers and magnetic rigidity band-pass filters, 25:57901

ELECTROMAGNETIC SEPARATION
- equipment for isotope, description of 180° ORSIS, 25:57650 (CONF-711002-, pp 10-20)
- equipment fcr, description of laboratory-type, 25:57649 (CONF-711002-, pp 1-9)

ELECTROMAGNETIC WAVES
- absorption by cold plasma, boundary effects on, (T), 25:59084 (CEA-CONF-1827)
- absorption in cylindrical column of cold magnetized plasma, (T), 25:59088
- damping in inhomogeneities in cold collisicnless plasma, (T), 25:59081(T) (AEC-tr-7272)
- interactions with plasma, effect on microinstabilities for anisotropic ion temperatures, 25:59083 (CEA-CONF-1826)
- propagation of large-amplitude TM, in magnetoactive plasma, (T), 25:59094
- propagation of wave tails from bounded oscillating electric charge, second approximation to Einstein--Maxwell equations for, 25:59350
- propagation on inhomogeneous plasma columns, surface, (E/T), 25:59100
- scattering on turbulent plasma, shf, (T), 25:58996
- sudden enhancements of field of, correlation with solar x-ray bursts, (E), 25:58888
- sudden phase anomalies in 223-Hz, correlation with solar x-ray bursts, (E), 25:58888
- transformation into plasma waves, coupled equations for, (T), 25:59105

ELECTROMAGNETISM
- theory for, classical field deformation of Poincare group for space--time torsion in, 25:59531
- theory of, self-interaction in finite, (T), 25:59221

ELECTRON BEAMS
- effectiveness for therapy, dosimetry and energy studies related to, 25:58075
- interactions with magnetized plasmas, heating in, (E), 25:58972
- interactions with plasma, density effects on wave transformation in, (E/T), 25:59104
- interactions with plasma, Doppler shifts at cyclotron frequency in, (E), 25:58997
- motion in crossed fields, boundary conditions for, (T), 25:58688

ELECTRON CAPTURE
- internal bremsstrahlung emission in, survey of research on, 25:59885

ELECTRON GAS
- correlation energy evaluation in magnetic field, grand-partition-function method for, (T), 25:59223

ELECTRON MICROSCOPES
- use of high-voltage, to simulate fast neutron-induced void swelling in metals, 25:58326
- void formation in specimens in high-vcltage, (T), 25:58316

ELECTRON MICROSCOPY
- conference on, 25:57910
- dislocation contrast in high voltage, 25:60292 (UCRL-20700)
- methods and uses of scanning, for studies of fractures in welds, 25:58215 (Y-DA-4280)

ELECTRON MULTIPLIER TUBES
- delay time of Bendix 4028 Channeltron, effects of aging on, 25:57895
- description for use with electrostatic analyzers for measurement of auroral electrons and protons, 25:57790
- gain of Bendix 4028 Channeltron, effects of aging cn, 25:57895

ELECTRON PAIRS
- production in e + e interactions, infinite-momentum quantum electrodynamic model for number and momentum distributions, total cross sections and amplitudes for, (T), 25:59345

ELECTRON SOURCES
- design of crossed-field, for injection into linacs, 25:59659(P)

ELECTRONIC FILTERS
- design of near-optimum, for coaxial transmission lines, 25:57892

ELECTRONS
- acceleration of relativistic cosmic, (T), 25:58830
- angular distribution at 350 to 1200 km at low latitude, (E), 25:58904
- channeling in crystals, review, 25:59165
- dosimetry in therapy, computer programs for, 25:58009
- effectiveness for therapy of neoplasms in man, additive effects of x radiation on, 25:58076
- effects of pulsed, on aqueous solutions of periodate, study of transient species from, 25:57466
- effects of pulsed, on aqueous, oxygenated, or pure pentane, absorption spectral studies of species from, 25:57458(R) (COO-1116-17)
- effects on alloys, interaction of coherent precipitates with damage in, 25:59163
- effects on antimony-doped germanium at 4 MeV, thermal-conductivity study of, 25:59134
- effects on aqueous solutions of carboxymethyl cellulose and gelatin at 1 MeV, 25:57443
- effects on argon--water systems, reactions of hydrogen from, 25:57460
- effects on carrier content, Hall mobility, and photoconductivity of n- and p-type cadmium telluride at 1 MeV, 25:59161
- effects on cathodoluminescence spectrum of beta-silicon carbide at 3.5 MeV, (E/T), 25:59139
- effects on doped n-type gallium arsenide at 1.5 to 2.0 MeV, effects of annealing on electric properties and photoluminescence spectra following, 25:59156
- effects on electric conductivity of rubidium chloride and potassium chloride--rubidium chloride crystals,

XUM

25:59172
effects on gold--15 at. percent silver alloys, crowdions induced in, (T), 25:59153
effects on gold--15 at. percent silver alloys, evidence for crowdion formation in, 25:59162
effects on growth of transplanted sarcomas in mice, effects of dose on, 25:58083
effects on induction of single-strand breaks in DNA of human lymphocytes, kinetics of repair of, 25:57958
effects on ir absorption of polished gallium arsenide at 1.5 MeV, spectral studies on, (E/T), 25:59155
effects on liquid propane of 35-MeV pulses of, solvated electrons induced in, 25:57468
effects on microstructure of graphite at 200 kV, 25:58168 (ORNL-4676, pp 139-233)
effects on n- and p-type silicon at 10 to 100 keV, subthreshold, 25:59127
effects on n-type germanium at 5°K, radiation annealing of defects induced in, 25:59132
effects on nucleic acid fragments in aqueous solutions, 25:57930
effects on point defect production in aluminum, relations of annealing with Stage I recovery from, 25:58341
effects on production of krypton fluorides, 25:57455
effects on silica and germania, ESR studies of defects induced in, 25:59174
effects on silicon surface-barrier detectors at 200 keV to 1 MeV, 25:57907
effects on silicon, review of defects produced in, 25:59135
effects on solid ammonia at 0.2 to 6 keV, ESR study of centers induced in, 25:57470
effects on surrounding tissues during human tumor therapy, effects of body inhomogeneities on, 25:58141
effects on synthesis of carotenoids in Japanese persimmons, effects of dose on, 25:57926
effects on tantalum foils at 1.0 to 3.2 MeV, anisotropy of swelling energy for production of Frenkel defects in, 25:59125 (JUL-729-FF)
effects on void formation in cobalt at 1 MV, 25:58325
effects on void formation in copper at 1 MV, (E/T), 25:58327
effects on void formation in neutron-irradiated nickel, 25:58333
effects on void formation in neutron-irradiated nickel, 25:58330
effects on void formation in nickel in high-voltage electron microscope at 280 to 600°C, 25:58328
effects on void formation in solids in high-voltage electron microscope, (T), 25:58316
effects on void formation in stainless steel at 1 MeV, relations with helium content, 25:58329
effects on void swelling in nickel in high-voltage electron microscope, 25:58326
emission from germanium bombarded by rare-gas ions, 25:59175
emission from germanium bombarded by rare-gas ions, angular dependence of secondary, (E/T), 25:59146
g-2 factor measurement in high field, sixth-order quantum electrodynamic contribution from, (E), 25:59560
interactions $e + d \to e + d$, effect of $\Delta(1236) - \Delta(1236)$ configuration admixtures on deuteron form factors for, (T), 25:59367
interactions $e + d$, Tamagaki and Hamada--Johnston potentials for elastic, 25:59335
interactions $e + e \to e + e + \pi^+ + \pi^-$, hadron electrodynamics in resonance model for, 25:59386
interactions $e + e$ at wide angles in quantum electrodynamics, 25:59354
interactions $e + e$ in colliding beams, differential cross sections for hadron production in deep inelastic, (T), 25:59371
interactions $e + e$, hadron production in deep inelastic $e + \gamma$ interactions in inelastic, (T), 25:59333 (JINR-E2-6036)
interactions $e + e$, infinite-momentum quantum electrodynamic model for number and momentum distributions, total cross sections, and amplitudes for production of electron pairs in, (T), 25:59345
interactions $e + e$, Regge-pole-theory prediction of scaling in hadron production in, (T), 25:59376
interactions $e + e$, two-photon generation mechanism for angular distributions and production cross sections for π^0 production in, (T), 25:59370
interactions $e + \gamma$ in inelastic $e + e$ interactions, hadron production in deep inelastic, (T), 25:59333 (JINR-E2-6036)
interactions $e + N$ in parton model, scaling in deep inelastic, 25:59431
interactions $e + N$, relativistic model for inelastic form factors, widths, and locations of N^* production in, (T), 25:59337
interactions $e + p \to e + \pi^0 + p$, differential cross sections for, (E), 25:59353
interactions $e + p \to e + \pi^0 + p$, test of dip mechanisms in hadron interactions using, (T), 25:59346
interactions $e + p$ up to 18 GeV at 18 to 34°, form factors, scaling, and cross sections for inelastic, (E), 25:59242
interactions $e + p$, asymptotic scaling of structure functions for, 25:59342
interactions $e + p$, field theory for Compton scattering amplitude and duality in deep inelastic current, (T), 25:59363
interactions $e + p$, hadron electrodynamics in resonance model for, 25:59386
interactions $e + p$, radiative corrections to inelastic, 25:59366
interactions $e + p$, two-photon generation mechanism for angular distributions and production cross sections for π^0 production in, (T), 25:59370
interactions $e + p$, vector dominance model for inelastic, 25:59365
interactions $e + p$, wee parton model for single-particle production, 25:59387
interactions $e^+ + e^- \to 3\pi$, relation between amplitudes for $\pi^0 \to 2\gamma$, $\gamma + \gamma \to 3\pi$, and, 25:59357
interactions $e^+ + e^- \to e^+ + e^- + \gamma + \gamma$, cross sections for π^0, eta, and eta' production in, 25:59389
interactions $e^+ + e^- \to e^+ + e^- + \gamma + \gamma$, proposal for experimental study of $\pi^0\gamma\gamma$, eta $\gamma\gamma$, and $X^0\gamma\gamma$ vertices from, 25:59253
interactions $e^+ + e^- \to e^+ + e^- + m\gamma$ at high energies, double-logarithmic approximation for bremsstrahlung cross sections for backward, (T), 25:59374
interactions $e^+ + e^- \to$ eta$^0(X^0) + \gamma$ in vector meson region, vector dominance model with linear and quadratic mixing of eta and X^0 for cross sections for, (T), 25:59377
interactions $e^+ + e^- \to N +$ anti N, production of S(1727), S(1414), d(1382), and d(1855) in colliding-beam, (T), 25:59358
interactions $e^+ + e^- \to p +$ anti p, scaling law for proton form factors for, 25:59361
interactions $e^+ + e^- \to p +$ anything, hadron electrodynamics in resonance model for, 25:59386
interactions $e^+ + e^- \to$ phi $\to \pi^- + \pi^+ + \gamma$, conformal symmetry for, 25:59542
interactions $e^+ + e^- \to \pi^0 + \gamma$ in vector meson region, vector dominance model for cross sections for, (T), 25:59377
interactions $e^+ + e^-$ at 1.4 to 2.4 GeV, analysis of elastic, (E), 25:59250
interactions $e^+ + e^-$ at 1.4 to 2.4 GeV, cross sections for multiple particle production in, (E), 25:59251
interactions $e^+ + e^-$ at high energies, integral equation for cross sections from partial waves with multi-Regge poles for bremsstrahlung amplitudes in backward, (T), 25:59369
interactions $e^+ + e^-$ in colliding beams, contribution to total cross section from bremsstrahlung mechanism for differential cross section for hadron production in, (T), 25:59375
interactions $e^+ + e^-$ in colliding beams, differential cross sections for hadron production in deep inelastic $e + e$ interactions from, (T), 25:59371
interactions $e^+ + e^-$ in crossed beams, Landau--Lifshitz process for cross sections for hadron production in, (T), 25:59334 (LNF-71/14)
interactions $e^+ + e^-$, cross section for heavy lepton production in, (T), 25:59390
interactions $e^+ + e^-$, Regge-pole-theory prediction of scaling in hadron production in, (T), 25:59376
interactions $e^+ + e^-$, total cross sections for W and e^+ production in colliding-beam, 25:59383
interactions $e^- + N \to e^- + N$ at high energies and low momentum transfers, Compton scattering cross sections for two-photon-exchange contribution to, (T), 25:59372
interactions $\gamma + e \to \gamma\ (2\gamma) + e$ in constant electromagnetic field, spectral and angular distributions for Compton and induced Compton, (T), 25:59368
interactions $\gamma + e$ with electron beams in crystals, anomalous transmission in, (T), 25:59228
interactions with hadrons at high energies, suppression of electromagnetic corrections to, (T), 25:59372
interactions with suprathermal protons, bremsstrahlung from, (T), 25:58837
motion in uniform magnetic field, synchrotron motion with radiation reaction for longitudinal velocity of, (T), 25:59359
propagator under harmonic force, functional integration methods for, 25:59349
radioinduced production of ammoniated, in aqueous solutions of hydrogen--potassium amide, 25:57477
reactions of organic monomers with solvated, rate constants of, 25:57475
reactions with alkali metal atoms, ionization in, (E), 25:58741
reactions with alkali metals, helium, and mercury atoms, excitation in, (E), 25:58741
reactions with atoms and ions having closed shells, construction of model potentials for, 25:58772
reactions with atoms and molecules, review of energy resolution in, 25:58747
reactions with atoms, approximate analytical expressions and scaling relations for excitation and ionization cross sections for, 25:58740
reactions with atoms, review of threshold laws for excitation and ionization in, 25:58745
reactions with atoms, semi-empirical formula for ionization cross sections for, 25:58738
reactions with barium, calcium, and strontium up to 1

keV, total cross sections for ionization in, (E), 25:58777
  reactions with carbon and nitrogen ions, cross sections for ionization in, (E), 25:58769
  reactions with carbon dioxide up to 300 eV, cross sections for emission produced by dissociative excitation, excitation, and ionization in, (E), 25:58760
  reactions with carbon dioxide, formation of metastable carbon monoxide and oxygen by dissociation in, (E), 25:58765
  reactions with carbon foils at 0.3 to 1.1 MeV, transition radiation in light emitted by, 25:58686
  reactions with carbon monoxide up to 300 eV, cross sections for emission produced by dissociative excitation, excitation, and ionization in, (E), 25:58759
  reactions with carbon-12, production of meson (π) in bound state from, 25:59355
  reactions with cesium and helium atoms, cross sections for ionization in, (T), 25:58738
  reactions with chlorine-35, production of meson (π) in bound state from, 25:59355
  reactions with copper at 12 to 30 keV, depth distribution of x rays produced in, (E), 25:58685
  reactions with diatomic molecules, selection rule for Σ^+--Σ^- transitions in, 25:58732
  reactions with gaseous molecules, K--LL Auger spectra from, (E), 25:58736
  reactions with germanium, secondary emission from, 25:58683 (FRNC-TH-49)
  reactions with hydrogen and oxygen molecules up to 350 eV, cross sections for vacuum ultraviolet emission from dissociative excitation in, (E), 25:58728
  reactions with hydrogen atoms, Glauber amplitudes for excitation of ns and np levels in, (T), 25:58766
  reactions with hydrogen molecules at 100 eV, cross section for Lyman-α emission in, (E), 25:58729
  reactions with metals at 12.5 to 22 MeV, bremsstrahlung yields from, 25:59106
  reactions with molecules, mechanisms for production of spurious dissociative attachment peaks in, 25:58730
  reactions with neon-20, production of meson (π) in bound state from, 25:59355
  reactions with oxygen ions up to 1 keV, cross sections for ionization in, (E), 25:58774
  reactions with oxygen molecules at 10, 15, and 20 eV, differential cross sections for excitation in, (E), 25:58732
  reactions with oxygen molecules up to 300 eV, cross sections for ultraviolet emission produced by dissociative excitation in, (E), 25:58758
  reactions with oxygen-containing molecules at 60 eV, production of excited oxygen ions (O^+) in, (E), 25:58763
  reactions with thin silicon crystals at 7 to 10 MeV, bremsstrahlung spectra from, (E), 25:59149
  scattering by argon at 10 keV, multiple ionization from inelastic, (E), 25:58754
  scattering by atoms having Z = 1 through 57 and 72 through 90 at 10 to 100 keV, factors for, 25:58748
  scattering by barium-138 at 200 and 500 MeV, differential cross sections for, (E), 25:59793
  scattering by carbon-12 at high energy, analysis using oblate deformed model, (T), 25:59729
  scattering by gases and solids of polarized, cross-section formulas for, 25:58687
  scattering by helium-4, analysis using Brueckner and Jastrow methods, 25:59704
  scattering by neodymium-142 at 129.4, 199.3, 299.1, and 499.5 MeV, differential cross sections for, (E), 25:59793
  scattering by nuclei through giant resonance and quasielastic regions, strong-coupling particle--hole analysis of, (T), 25:59869
  scattering by nuclei, radiative corrections for elastic, 25:59880
  scattering by oriented holmium-165 at 160.6 to 452.2 MeV, cross sections and electric charge distributions from elastic, (E), 25:59796
  scattering from atoms and molecules, compound states in, (T), 25:58804
  spectra from polarized μ decay, 25:59404
  spectra of relativistic cosmic, (T), 25:58830
  theory for free, strong correlation between Cherenkov effect and properties of photon tachyons in disappearing Fresnel wave in, (T), 25:59573
ELECTROPHORESIS
  method for preparation of radiation targets, 25:58183 (CONF-711002-, pp 160-5)
ELECTROSTATIC ANALYZERS
  description for use with channel electron multipliers for measurement of auroral electrons and protons, 25:57790
ELEMENTARY PARTICLE MODELS
  cascade evaporation, Monte Carlo method for calculating π and N reactions with nuclei at 0.01 to 100 GeV in, 25:59508(T) (ORNL-tr-2514)
  dual quark, functional integral approach to, 25:59435
  dual resonance, one-loop amplitudes in Neveu--Schwarz, 25:59433
  dual resonance, quark diagrams for loop terms in, 25:59445
  dual resonance, quark interpretation in operator formalism of, 25:59441
  dual resonance, removal of trajectory degeneracy in, 25:59457
  dual resonance, zeros of multiparticle amplitudes in, 25:59625
  dual, connections of average multiplicity and average perpendicular momentum for interactions at high energies in, 25:59322 (NP-19024)
  dual, five-point function for anti p + n $\to 2\pi^- + \pi^+$ interactions at rest in, 25:59465
  dual--cut, for unstable particles, 25:59439
  dyon, scale invariance breaking and Regge trajectories for hadrons in, 25:59430
  isobar, planar duality constraints on multibody, 25:59446
  Lee, decays of interfering unstable V-particles in, nonexponential, 25:59438
  Lee, properties of, 25:59575
  multi-Regge, connections of average multiplicity and average perpendicular momentum for interactions at high energies in, 25:59322 (NP-19024)
  multiperipheral, connections of average multiplicity and average perpendicular momentum for interactions at high energies in, 25:59322 (NP-19024)
  one-pion-exchange, effective mass spectrum for π system in $\pi + N \to m\pi + N$ interactions in, 25:59496
  optical, particle interactions at intermediate energies for equivalence of Regge and, 25:59421 (COO-2009-30)
  parton, Galilean invariance in infinite momentum frame for, 25:59431
  quark--parton, form factors of nucleons in, 25:59391
  quartet and three-triplet, urbaryon transitions for nonleptonic hyperon decays in, 25:59423
  sigma, six-π amplitude to fourth order in momenta in nonlinear, 25:59456
  statistical thermodynamic, asymptotic form of transverse-momentum distribution of secondary particles from strong interactions at high energies in, 25:59427
  statistical, Lorentz-invariant and -noninvariant momentum space in thermodynamic, 25:59432
  vector dominance, cross sections for $e^+ + e^- \to \pi^0 + \gamma$ and $e^+ + e^- \to$ eta(X^0) + γ interactions in vector meson region in, 25:59377
  vector dominance, k^2 dispersion relation for invariant amplitudes of π production in $\gamma + N \to \pi + N$ interactions in, 25:59351
  Veneziano, amplitude for $A + \pi \to A + \pi$ interactions in, 25:59464
  Veneziano, finite energy sum rules in dual, 25:59450
  Veneziano, group theory for structure of generalized, 25:59628
  Veneziano, Radon transforms for structure of generalized amplitudes in, 25:59627
  Veneziano, representations for π form factor and photon coupling to vector mesons in, 25:59352
ELEMENTARY PARTICLE MODELS (TRIPLET)
  hadron mass spectra and bound states in quark, 25:59426
  interactions $\gamma + n \to \gamma + n$ and $\gamma + p \to \gamma + p$ in extended quark, differential and total cross sections for, 25:59378
  quark diagrams in, size of dual loop term from, 25:59445
  review on quark, 25:59437
ELEMENTARY PARTICLES
  canonical states at infinite momentum, light-like and space-like representations for transformation properties of, (T), 25:59321 (JINR-E2-5993)
  electromagnetic interactions of, generalization of Cook formalism for Fock space for two-body Coulomb, (T), 25:59580
  form factors of, algorithms for γ-algebra of electromagnetic, (T), 25:59360
  formalism for two-particle system with spins 0 and 1/2, quasipotential, (T), 25:59422 (JINR-E2-6046)
  helicity states at infinite momentum, light-like and space-like representations for transformation properties of, (T), 25:59321 (JINR-E2-5993)
  interaction of unstable, 25:59616
  interactions at high energies, configuration-space representation for, 25:59617
  interactions at high energies, connections of average multiplicity and average perpendicular momentum in models for, (T), 25:59322 (NP-19024)
  interactions at high energies, Lorentz-invariant and -noninvariant momentum space in statistical model for, 25:59432
  interactions at high energies, polarization properties of particles produced in, (T), 25:59328
  interactions at intermediate energies, equivalence of Regge and optical models for, (T), 25:59421 (COO-2009-30)
  interactions in two-particle system with spin 0 and 1/2, quasipotential equations for amplitude of, (T), 25:59422 (JINR-E2-6046)
  interactions near phase-space boundary, Feynman relation for particle production in inclusive, 25:59332
  interactions of arbitrary-mass and -spin, crossing symmetry of partial waves, tests of crossing-symmetric models, and multivariable expansion of amplitudes for, (T), 25:59619
  interactions of spinning, lightlike, continuous-spin, and

XUM

spacelike representations of Poincare group for analysis in Lorentz partial waves of amplitudes of, (T), 25:59532
interactions of spinning, Lorentz basis of Poincare group for timelike, lightlike, and spacelike momenta for partial-wave analysis of amplitudes of, (T), 25:59533
interactions of zero-spin, equal-mass, upper bound on absorptive part of elastic, (T), 25:59630
interactions of, eikonal approximation for inelastic, 25:59330
interactions of, generalization of Cook formalism for Fock space for two-body Yukawa, (T), 25:59580
interactions of, sum rules for cross sections of inclusive, 25:59331
interactions of, violation of Pomeranchuk theorem and odd-signature amplitude for, 25:59329
motion in refracting medium, (T), 25:59325
production in interactions at high energies, polarization properties for, (T), 25:59328
production in interactions at high energies, two-bump structure of angular distributions for multiple, (T), 25:59327
reactions with A = 3 nuclei at high energies, relativistic Feynman graphs in momentum representation for method for calculating amplitudes of, (T), 25:59528
strong interactions at high energies, statistical thermodynamic models for asymptotic form of transverse-momentum distribution of secondary particles from, (T), 25:59427
strong interactions at high energies, two-particle correlations in inclusive, 25:59436
strong interactions at high energies, two-Reggeon exchange contribution to amplitudes of, (T), 25:59618
strong interactions at large momentum transfer, properties of inclusive, 25:59444
strong interactions of, point-source static model for renormalized field product for Bjorken limit and Ward identity for, (T), 25:59564
symmetries for review on group theory for, 25:59530
theory for dyons, 25:59447
transformation properties of canonical and helicity states at infinite momentum for, light-like and space-like representations for, (T), 25:59321 (JINR-E2-5993)
wave function for two-particle system with spins 0 and 1/2, quasipotential equations for, (T), 25:59422 (JINR-E2-6046)
weak interactions of, relation of hadronic mesons to isospin selection rules in, 25:59393
weak interactions of, relation with Lagrangian for n + p → d + γ interactions for effective Lagrangian for nonleptonic, (T), 25:59418
weak interactions of, two- and four-component neutrino theories from leptonic and semileptonic, (T), 25:59407

ELEMENTARY PARTICLES (TRIPLET)
binding of quarks to hydrogen and helium ions, electronic structure of molecular, 25:59344
existence of quarks in hydrogen and helium molecules, (T), 25:59344
search for quarks, low-temperature techniques for, (E), 25:59240
strong interactions at high energies in quark, relation with coherent state method for, 25:59448 (JINR-E2-6025)

ELEMENTS
determination by recoilless resonance absorption or scattering of γ rays, 25:57354(P)
determination of trace amounts of heavy, in bulk light material, nuclear scattering methods for, 25:57360
determination of trace amounts of light, in heavy bulk materials, nuclear reaction methods for, 25:57360
electron scattering at 10 to 100 keV by Z = 1 through 57 and 72 through 90, factors for, 25:58748

EMBRYOS
cleft palate and oligodactylia induction in mouse, following in utero exposure to cyclophosphamide, 25:58127
radiation effects on DNA and RNA synthesis in amphibian, effects of dose on x, 25:57944
radiation effects on incidence of cleft palate and oligodactylia in mouse, in utero exposure x, 25:58127

ENVIRONMENT
radioactivity from artificial and natural sources in relation to human populations, 25:57994
radioactivity of Aiken, S. C. and Oak Ridge, Tenn. during 1969, 25:57985

ENZYMES
effects on incision and excision of uv-irradiated Escherichia coli DNA, 25:57928
effects on release of nucleotides from uv-irradiated Escherichia coli DNA, 25:57928
properties of uv-endonuclease and uv-exonuclease from Micrococcus luteus responsible for excision of photoproducts, 25:57935
role in repair of uv- and x-radioinduced breaks in DNA of mammalian cells, 25:57943

EPITHELIUM
radiation effects on human, following therapy for cervical tumors, cytology and histology of γ, radium, and x, 25:58140

EPOXY RESINS
Cu--epoxy resin, radiation effects on strength of joints of, gamma, 25:58416(R) (RLO-2098-2)
epoxy resin--stainless steel, radiation effects on strength of joints of, gamma, 25:58416(R) (RLO-2098-2)
epoxy--graphite, tensile properties of fiber-reinforced composites of, 25:58382

ERBIUM
complexes with HEDTA, dissociation constants for, 25:57537
energy levels of, identification of 4f/sup N-1/6s^{2}6p configurations in, 25:58706
oxidation potential for trivalent--tetravalent, 25:57437

ERBIUM ISOTOPES Er-166
neutron reactions (n,α) at 14.2 MeV, presence of direct effects in spectra from, (E/T), 25:59802

ERBIUM ISOTOPES Er-168
neutron reactions (n,α) at 14.2 MeV, presence of direct effects in spectra from, (E/T), 25:59802

ERBIUM ISOTOPES Er-170
preparation of monocrystalline, by grain growth annealing, 25:58184 (CONF-711002-, pp 181-90)

ERBIUM OXIDES
reduction to metal using thorium with simultaneous distillation separation, 25:58184 (CONF-711002-, pp 181-90)

ERYTHROCYTES
radiation effects on chemical properties and ultrastructure of in vitro pigeon, uv, 25:58113
radiation effects on count of, in medical personnel in Japan during 1969, survey of, 25:58134
radiation effects on survival of chromium-51-labeled human, in vivo following exposure in vitro, γ, 25:58136

ETHANE, CHLORO-
spectra of, effects of deuterium on vibrational, 25:57422

ETHER, BUTYL VINYL
reactions with solvated electrons, rate constant of, 25:57475

ETHER, ISOBUTYL VINYL
radioinduced polymerization under superdry conditions, γ, 25:57450 (ORO-3667-1)

ETHER, ISOPROPYL VINYL
radioinduced polymerization under superdry conditions, γ, 25:57450 (ORO-3667-1)

ETHYLENE
radiolysis of gaseous, in presence of 2-methylpropene, yields from γ, 25:57474
reactions with solvated electrons, rate constant of, 25:57475

ETHYLENE, CHLORO-
radioinduced polymerization under superdry conditions, γ, 25:57450 (ORO-3667-1)

ETHYLENE, CHLORO-, POLYMERS
reactions of O rings of, with fluorine, 25:57619 (RFP-1739)

ETHYLENE GLYCOL
radioprotective effects on Escherichia coli, γ, 25:58157

ETHYLENE OXIDE
radiolysis of clathrate hydrates of, stability of radicals from γ, 25:57476

ETHYLENE POLYMERS
positron emission from positron-bombarded, 25:58681
radiation effects on thermostability of, effects of antioxidants and fillers on, 25:57446
radioinduced disorientation of, gamma, 25:58417
radiolysis of low-density, effects of antioxidants on thermooxidative degradation in γ, 25:57462
Al$_2$O$_3$--polyethylene, radiation effects on mechanical properties and creep resistance of composites of, gamma, 25:58416(R) (RLO-2098-2)
CaCO$_3$--polyethylene, radiation effects on mechanical properties and creep resistance of composites of, gamma, 25:58416(R) (RLO-2098-2)
carbon black--polyethylene, radiation effects on mechanical properties and creep resistance of composites of, gamma, 25:58416(R) (RLO-2098-2)
glass fibers--polyethylene, radiation effects on mechanical properties and creep resistance of composites of, gamma, 25:58416(R) (RLO-2098-2)
MgO--polyethylene, radiation effects on mechanical properties and creep resistance of composites of, gamma, 25:58416(R) (RLO-2098-2)
NaAlSiO$_4$--polyethylene, radiation effects on mechanical properties and creep resistance of composites of, gamma, 25:58416(R) (RLO-2098-2)
polyethylene--silicon oxides, radiation effects on mechanical properties and creep resistance of composites of, gamma, 25:58416(R) (RLO-2098-2)

EUMYCOTA
Neurospora sp., radiation effects on, effects of diepoxybutane on photoreactivation of mutagenic uv, 25:57954
radiation effects on populations of microfungi in litter of red oak, effects of dose on γ, 25:58150
Saccharomyces cerevisiae, radioinduced mutations in, studies on genetic control of uv and x, 25:57976
Ustilago maydis, radiation effects on genetic repair and synthesis of nitrate reductase in, uv, 25:57955
yeasts, radiosensitivity of, correlation of aminopterin sensitivity with x, 25:57927
yeasts, radiosterilization of wine, additive effects of

ultrasound on uv, 25:58158

EUROPE
  fallout monitoring during 1970, 25:57980(R) (HASL-245)
  nuclear power plants in, development of, 25:59901
  radioisotope content of diet during 1969, cesium-137 and strontium-90, 25:57979 (EUR-4667)

EUROPIUM
  determination in fluorite by solvent extraction and spectrography or fluorimetry, 25:57332
  determination in silicate rocks by neutron activation, low-energy photon detector for, 25:57387
  determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
  oxidation potential for trivalent--tetravalent, 25:57437
  separation from neodymium and samarium in chloride solution by solvent extraction using DEHPA in heptane, factors for, 25:57543
  separation from other rare earths by electrophoresis in Complexon III on cellulose or silica gel, 25:57299
  separation from sodium perchlorate solution by solvent extraction into organic solvents using dibutyl ethylenediphosphonate, 25:57544

EUROPIUM ISOTOPES
  determination by neutron activation and γ spectroscopy, 25:57391

EUROPIUM ISOTOPES Eu-153
  nuclear spin--spin interaction in europium oxide, indirect, (E/T), 25:59200

EUROPIUM OXIDES
  effects on structure of γ-irradiated sodium oxide--tellurium oxide glasses, EPR spectral studies on, 25:57447
  europium-153 spin--spin interaction in EuO, indirect, (E/T), 25:59200

EVAPORATORS
  design for continuous concentration of radioactive waste water, 25:57900(P)
  thermodynamic behavior of multiflash, model for calculation of, 25:57616 (LFEN-NI.-54-a)

EXPERIMENTAL BREEDER REACTOR-II
  core materials for, production of helium by nuclear reactions in, 25:58163(R) (AI-AEC-12859)
  flowmeter for, performance of permanent magnet flow-through liquid sodium, 25:60182
  fuel element cladding failures in, sodium soluble isotopic tagging methods for location of sodium bonded, (T), 25:60083 (ANL-7785)
  fuel elements for, detection and identification methods for leaking, (E), 25:60082 (ANL-7782)
  instrumentation for, development of fission product monitoring, 25:60005(R) (ANL-7854)
  operations during August 1971, 25:60005(R) (ANL-7854)
  physics measurements for, 25:60005(R) (ANL-7854)

EXPLOSIONS
  shock waves from above-ground and underground, finite difference method for calculation of, 25:57594 (UCRL-73369)

EXPLOSIVES
  shipping by rail or motor vehicle, US Dept. of Transportation regulations for, 25:57710

EXPONENTIAL PILES
  core configuration for STSF-9, 25:60156(R) (GULF-RT-A-10800)
  criticality calculations for STSF-9, 25:60156(R) (GULF-RT-A-10800)
  neutron spectra in STSF-9, (E/T), 25:60156(R) (GULF-RT-A-10800)

EXTRACELLULAR SPACE
  analysis of human, for bromine, potassium, and sodium, radioisotope dilution method for, 25:57924

EXTRACTION APPARATUS
  design and operation of jet-mixed liquid--liquid column-type, 25:57623(P)
  design for separating impurities from sodium coolants for analysis, 25:57624(P)

EYES
  radiodiagnosis of melanomas in human, phosphorus-32 uptake test for, 25:58063
  radiodiagnosis of melanomas of human, using phosphorus-32 uptake and semiconductor detectors, 25:58064

F

FALLOUT
  deposition on North America in Jan. 1964, effects of major stratospheric--tropospheric mass exchanges on, 25:57572(R) (COO-1340-24)
  effects on strontium-90 content of plants and soils in East Germany from 1960 through 1963, 25:57986
  monitoring in atmosphere over Sweden following 10th Chinese nuclear explosion, 25:57580
  monitoring in Central, North, and South America during 1970, 25:57981(R) (HASL-245(App.))
  monitoring in EURATOM countries during 1969, 25:57979 (EUR-4667)
  monitoring in Europe, New Zealand, and USA during 1970, 25:57980(R) (HASL-245)
  monitoring in Swedish atmosphere following Dec. 27, 1968 Chinese nuclear explosion, 25:57577
  monitoring in western hemisphere during 1971, 25:57984
  monitoring of Schooner Event, data from off-site environmental, 25:57574 (PNE-524)
  radioisotope content of milk samples collected in Central, North, and South America during April 1971, barium-140, cesium-137, iodine-131, strontium-89, and strontium-90, 25:57983

FAST FLUX TEST FACILITY
  control system for, development of standards for, 25:60180
  fuels for, development of methods for chemical analysis for, 25:58344(R) (LA-4693)
  in-pile loops for, development of on-line meter modules for impurity monitoring in, 25:60058(R) (ANL-7817)
  instrumentation for, development of standards for, 25:60180
  structural elements of, effects of stainless-steel property data on rules for design of, 25:60115 (HEDL-SA-164)

FAST TEST REACTOR
  accidents in, analysis of aerosol distributions in containment structures following, (E/T), 25:60148 (AI-69-Memo-95)
  containment structures for, distribution of accident released aerosols in, (E/T), 25:60148 (AI-69-Memo-95)
  coolant for, monitoring and sampling system for liquid sodium, 25:60005(R) (ANL-7854)
  core vessel for, effects of stored fuel on neutron flux in, (T), 25:60055(R) (ORNL-TM-3573)
  flowmeter for, development of eddy current probe liquid sodium, 25:60184
  flowmeter for, development of permanent magnet probe liquid sodium, 25:60183
  instrumentation for, development of, 25:60005(R) (ANL-7854)
  neutron flux monitor guide tubes for, shielding of low-level, (T), 25:60055(R) (ORNL-TM-3573)
  shielding for, discrete ordinates analysis of core support grid-plate, (E/T), 25:60055(R) (ORNL-TM-3573)
  shielding for, effects of composition on neutron transmission of thermal, (T), 25:60055(R) (ORNL-TM-3573)
  shielding of, effects of sodium coolant holes configuration on neutron streaming in grid-plate, (E), 25:60158 (ORNL-TM-3514)
  shutdown margin measurements for, two frequency reactor noise method for, (T), 25:60043

FASTENERS
  failure of threaded, at nuclear facilities, data review on corrosion, fatigue, and galling, 25:57618 (ORNL-TM-3570)

FECES
  analysis for α, β, and γ emitters, methods used at CNEN, 25:57347 (RT/PROT-(71)9)

FEDERAL REPUBLIC OF GERMANY
  power plants in, development predictions to 1980, 25:59889
  power reactor development program in, 25:60012 (JUL-775-RG)
  power reactors for, design characteristics and economic aspects of gas cooled fast breeder, 25:60013 (KFK-1375)
  radioactive waste processing and disposal in, 25:57540

FEEDBACK SYSTEMS
  development of pulsed, for radiation detectors, 25:57812

FERMI FAST BREEDER REACTOR
  operations during May 1971, 25:59908 (DOCKET-50016-130)

FERMI POWER REACTOR, UNIT 2
  effluents from, effects on environment of chemical, radioactive, and thermal, 25:59986 (DOCKET-50341-34)
  site for, geological and meteorological data for, 25:59986 (DOCKET-50341-34)

FERMIONS
  collective modes in Fermi liquids, 25:58920
  field theory for, spinor hyperplane, (T), 25:59553
  formalism for two-particle system with spins 0 and 1/2, quasipotential, (T), 25:59422 (JINR-E2-6046)
  interaction of many-body system of, resolution of hierarchy of Green function for, 25:59218
  interactions with spin-0 bosons in two-particle system, quasipotential equations for amplitude of, (T), 25:59422 (JINR-E2-6046)
  theory for ground-state energy of system of, 25:59233
  theory for interacting system of, one-dimensional, 25:59230
  wave function for two-particle system with spins 0 and 1/2, quasipotential equations for, (T), 25:59422 (JINR-E2-6046)

FERMIUM
  oxidation potential for trivalent--tetravalent, 25:57437

FERMIUM ISOTOPES Fm-257
  production by target irradiation in HFIR and processing in TRU, 25:57524 (ORNL-TM-3343)

FERTILIZERS
  analysis for molybdenum by atomic absorption spectrophotometry, 25:57306

FIELD THEORY
  scalar fields in, solutions for system of gravitational, electromagnetic, and massless, 25:59587
  spinor hyperplane, for fermions, 25:59553

FILTERS
  design parameters of research reactor cooling system,

XUM

- 25:60157 (INR-1316)
  - dust collection by membrane, beta radiometric gage for measuring, 25:57870
  - performance of research reactor cooling system, 25:60157 (INR-1316)
  - radioactivity of air, high speed autoradiographic method for measurement of polonium-210 or plutonium-239, 25:57998 (NIRS-Pu-8)
- FINS
  - effects of cooling, on heat transfer from tubular fuel elements in central channel of natural uranium gas-cooled reactor, (E/T), 25:57639 (JUL-753-RB)
- FIRES
  - detection of, radiometric system for, 25:57873(P)
- FISSION
  - asymmetry in, liquid-drop calculation of mass parameter for, (T), 25:59874
  - data analysis of, computer program for, 25:59773 (AD-721481)
  - R-matrix parameters for interfering resonances with two channels for, ambiguities in, 25:59829 (COO-2022-11)
  - theory of phase transitions in, in state-independent pairing-plus-quadrupole model in cluster representation, (T), 25:59867
- FISSION FRAGMENTS
  - mass yields from bismuth-209 photofission, (E), 25:59816
  - neutron emission by californium-252, variance of, (E), 25:59824
- FISSION PRODUCTS
  - activity of plutonium-239 and uranium-236, analysis of data on, beta and gamma, 25:59813
  - deposition in reactor containment buildings, effects of heat transfer characteristics on, (T), 25:60111(R) (BMI-1917)
  - deposition on MSRE graphite, evaluation by Auger electron spectroscopy, 25:58168 (ORNL-4676, pp 139-233)
  - determination in cover gas for sodium coolant, development of methods for, 25:60058(R) (ANL-7817)
  - diffusion from graphite, mechanism for, 25:58367 (EUR-4327)
  - diffusion from uranium dioxide fuel particles, effects of aluminum oxide and niobium oxide doping on, 25:58347 (JUL-730-RW)
  - effects on determination of oxygen and nitrogen by neutron activation, 25:57390
  - fast neutron fission yields of measurement in, liquid metal cooled fast breeder reactors of, (E), 25:60035(R) (ANL-7824)
  - production in liquid metal cooled fast breeder reactors, measurement of, (E), 25:60035(R) (ANL-7824)
  - reactions of, design of loop for study of fissiochemical, 25:57613 (JAERI-Memo-4446)
  - reactivity worths of fast reactor, integral measurement of, (E/T), 25:60034 (AE-428)
  - reactivity worths of fast reactor, measurement of, 25:60159 (RCN-150)
  - release in reactor coolant loss accidents, evaluation of source-term guidelines for estimation of, 25:60111(R) (BMI-1917)
  - removal by sodium thiosulfate in ice cubes of ice condenser reactor containment systems, (E), 25:60124
  - separation from uranium, properties of styrene--divinylbenzene polymers for chromatographic, 25:57527 (UJV-2557-Ch)
  - separation of berkelium from, by sorption on zirconium phosphate--silicate, 25:57530
  - separation of rare earths and yttrium from, by electromigration following complexing with nitrilotriacetic acid, 25:57558
  - separation of ruthenium tetroxide from, by ferric oxide--silica filters, 25:57532
  - solubility in ceramic reactor fuels, measurement of, 25:58411(R) (GEAP-12217)
- FLOWMETERS
  - development of eddy current probe liquid sodium, 25:60184
  - development of permanent magnet probe liquid sodium, 25:60183
  - performance of permanent magnet flow-through liquid sodium, 25:60182
- FLUID FLOW
  - analysis in reactors, book on, 25:60222
  - effects of low Mach number, on acoustically-induced vibration of slender rods in fluid-filled tube, (E/T), 25:57621 (TRG-Report-2141)
  - electrohydromagnetic instability of superposed, 25:58842
  - magnetohydrodynamic boundary layer, plane nonstationary, 25:58847
  - magnetohydrodynamic duct, optimal distribution of tensor of specific resistance of working substance in, (T), 25:58845
  - magnetohydrodynamic turbulent, considering Hall effect, (T), 25:58849
  - magnetohydrodynamic, stability of compression shocks in channel flow, 25:58848
  - magnetohydrodynamic, two-dimensional channel flow in nonuniform magnetic fields, (T), 25:58843
  - velocity of, radiometric equipment and method for measuring, 25:57667(P)
- FLUIDS
  - neutron scattering spectrum of simple, theory of, 25:59678
- FLUORIDES
  - purification of molten, method for continuous, 25:57522 (ORNL-4676, pp 234-71)
- FLUORINATION
  - equipment for, corrosion and development of frozen-wall, 25:57522 (ORNL-4676, pp 234-71)
- FLUORINE
  - determination as fluoride using Chloramine-T, 25:57393
  - radioinduced reactions with krypton, electron or proton, 25:57455
  - reactions with glovebox construction materials, test results on, 25:57619 (RFP-1739)
- FLUORINE IONS
  - reactions with neon and nitrogen molecules in keV range, production of K vacancies in, (E), 25:58756
- FLUORINE ISOTOPES F-18
  - energy levels from nitrogen-14 (α,γ) reactions, lifetimes, spin--parity assignments, and widths for 4p--2h rotational, (E), 25:59715
  - energy-level transitions from nitrogen-14 (α,γ) reactions, branching ratios and strengths for E2, (E), 25:59715
  - radiation effects on uptake by fractured bone, radiography of x, 25:58105
- FLUORITES
  - analysis for rare earths by solvent extraction and spectrography or fluorimetry, 25:57332
- FOOD
  - analysis for mercury by neutron activation and radiochemical separation, 25:57392
  - analysis for trace elements, review on methods for, 25:57913
  - radioactive contamination of, from artificial and natural sources in relation to human populations, 25:57994
  - radioactivity in Switzerland during 1969, 25:57989
  - radioactivity in Switzerland during 1970, 25:57988
  - radioisotope content in Kiev region of Soviet Union, 25:57987
  - trace element content in Kiev region of Soviet Union, 25:57987
- FORBUSH DECREASES
  - rigidity dependence in cosmic-ray intensity, comparison with 11-year variation, (E/T), 25:58823
- FORENSIC SCIENCE
  - activation analysis uses in, 25:57373
  - activation analysis uses in, 25:57374
- FORKED RIVER POWER REACTOR, UNIT 1
  - design parameters of, revised and additional data on, 25:59991 (DOCKET-50363-18)
  - operations aspects of, revised and additional data on, 25:59991 (DOCKET-50363-18)
- FORMALDEHYDE
  - radiosensitizing effects on Escherichia coli, γ, 25:58157
- FORMATES
  - effects on chemical state of recoil phosphorus-32 from neutron-irradiated tripolyphosphate hexahydrate, 25:57495
- FORT CALHOUN POWER REACTOR, UNIT 1
  - construction of, request for not suspending permit for, 25:59964 (DOCKET-50285-49)
- FORT ST. VRAIN POWER REACTOR, UNIT 1
  - construction of, request for not suspending permit for, 25:59955 (DOCKET-50267-34)
- FREQUENCY METERS
  - design and construction of four-decade digital log, 25:57893
- FRUCTOSE
  - radiation effects on metabolism in pea and wheat plants and their offspring, gamma, 25:57931
- FRUITS
  - persimmons, radiation effects on synthesis of carotenoids in Japanese, effects of dose on electron, 25:57926
- FUEL CAPSULES
  - fabrication of plutonium-238 heat source, for cardiac pacemaker, welding methods for, 25:57657(R) (NUMEC-4189-6)
  - materials for, research progress on development of, 25:57654(R) (DP-1279)
- FURAN, TETRAHYDRO-
  - radiolysis of hydrates of, EPR studies on free radicals from γ, 25:57465
- FURNACES
  - heating elements for, fabrication and performance of zirconium dioxide, 25:58357
  - wear of refractory linings in, tracer techniques for measurement of, 25:57677
- FUSED SALTS
  - corrosive effects on MSRE materials, status of loop tests on, 25:58168 (ORNL-4676, pp 139-233)
  - sound velocity in, effects of entropy on, 25:57298 (ORNL-4676, pp 73-138)

G

- GADOLINIUM
  - complexes with HEDTA, dissociation constants for, 25:57537
  - determination in silicate rocks by neutron activation,

  - low-energy photon detector for, 25:57387
  - electron spin resonance spectra in gold, crystal-field fine structure in, 25:59192
  - energy level interactions in Gd IV, 4f--5d, (T), 25:58697
  - energy levels of, identification of 4f/sup N-1/$6s^2 6p$ configurations in, 25:58706
  - magnetic equation of state near Curie point, (E), 25:59181
  - optical properties at 1.13 to 3.96 eV, 25:59187
  - oxidation potential for trivalent--tetravalent, 25:57437
  - photochemistry of dilute sulfuric acid solutions of, formation of hydrates of peroxides in, 25:57416
- GADOLINIUM ALLOYS AND SYSTEMS
  - Au-base--Gd, electron spin resonance spectra in single crystals of, crystal-field fine structure in, 25:59192
  - Gd--Sm, magnetic properties at 77 to 1100°K, 25:59176
- GADOLINIUM ISOTOPES
  - energy level transitions of, structural corrections in pair conversion coefficients in M1, (T), 25:59861
- GADOLINIUM OXIDES
  - fabrication of radioisotope fuel forms of, as stand-in for curium-244 oxide, hot pressing method for, 25:57653 (DP-1270)
  - magnetic susceptibility and transformation temperatures of cubic and monoclinic, effects of substoichiometry on, 25:59198
- GAGES AND METERS
  - design of static detector, 25:60275 (MHSMB-24)
- GALAXIES
  - blue stellar objects associated with, (E), 25:58539
  - colors of compact, (E), 25:58648
  - distribution of compact, spatial, (E), 25:58648
  - evolution of nuclei of, from quasars, (T), 25:58626
  - formation of, from chain fragmentation of quasags, (T), 25:58523(T) (CSIRO-Trans-10650)
  - fragmentation in nuclei of active, (T), 25:58668
  - identification of AP Lib with PKS 1514-24, (E), 25:58658
  - identification of young, criteria for, (T), 25:58625
  - infrared photometry of NGC 4151, 25:58654
  - mass distribution function for clusters of, (E), 25:58643
  - mass--luminosity ratio for elliptical and lenticular, (E/T), 25:58635
  - mass-to-light ratio for clusters of, (E), 25:58643
  - model for, collective instabilities and waves in, (T), 25:58656
  - model for, normal modes problem in self-consistent plane-parallel slab, (T), 25:58656
  - origin of, (T), 25:58666
  - photometry of nucleus of NGC 3627, (E), 25:58633
  - radio emission from core sources in, at 1415 MHz, (E), 25:58642
  - radio emission from quasi-stellar, (T), 25:58523(T) (CSIRO-Trans-10650)
  - radio interferometric study of Maffei 2, at 21 cm and adjacent continuum, (E), 25:58632
  - spectra of AP Lib, (E), 25:58658
  - spectra of compact, (E), 25:58648
  - spectral line intensities of nuclei of, (T), 25:58629
  - stability of spherical, (T), 25:58430
  - star distribution in spiral, supernovae and young Population I, (T), 25:58646
  - stellar evolution of M31, disk-population, (E/T), 25:58491
  - stellar populations in, (T), 25:58636
- GALLIUM
  - determination by extraction using quinolinol melt and spectrography, 25:57312
  - effects on complexonometric determination of rare earths, 25:57317
  - radioinduced production in germanium, effects on infrared absorption, 25:58343
- GALLIUM ALLOYS AND SYSTEMS
  - Ga--In, structure of molten, quasi-eutectic, 25:58276
  - Ga--Sb, radiation damage in GaSb, review of, 25:59138
  - Ga--U, magnetic transition temperature of UGa_2, 25:59190
  - Ga--V--Y, phase studies of, 25:58289
- GALLIUM ARSENIDES
  - analysis for oxygen by 14-MeV neutron activation and γ spectrometry, 25:57376
  - dislocations in, heterogeneous, 25:60291 (UCRL-20525)
  - ion implantation in, review, 25:59168
  - ion-implantation damage in, luminescence study of 400-keV zinc, (E/T), 25:59141
  - radiation damage in GaAs, review of, 25:59138
  - radiation effects on ir absorption of polished, spectral studies on electron and fission-neutron, (E/T), 25:59155
  - radioinduced defects in doped n-type, effects of annealing on electric properties and photoluminescence spectra following electron, 25:59156
  - superconductivity of, at high pressures, (E), 25:58944
- GALLIUM ISOTOPES Ga-67
  - effectiveness for scintigraphy of human lymph system for localization of neoplasms, 25:58055
  - uptake of citrate-incorporated, by neoplasms of human liver, 25:58045
- GAMMA CAMERAS
  - development of multiple proportional detector, 25:57774
  - development of self-triggered wire spark chambers for clinical, 25:57784
- GAMMA CROSS SECTIONS
  - data libraries for group-averaged discrete-ordinate, computer programs for, 25:59843 (SC-DR-710320)
  - measurement of, description of fully automatic system for, 25:59772
- GAMMA DECAY
  - parity non-conserving interaction current contributions to, (T), 25:59856
- GAMMA RADIATION
  - buildup in industrial testing, analytical method for evaluation of, 25:57681
  - buildup of, from low-level sources, (E), 25:59120
  - detection and measurement of, self-powered detectors for, 25:57777
  - detection of, characteristics of multiplying semiconductor detectors for, 25:57748
  - detection of, full-energy peak efficiency calibration of well-type lithium-drifted germanium detectors for, 25:57740
  - detection of, physical properties and scintillation performance of barium fluoride for, 25:57817
  - dose distribution in mammary glands during pendulum and tangential therapy, calculation and comparison of, 25:58003
  - dose planning in therapy, computer programs for, 25:58008
  - dose rate calculations for two-layered slab shields, using Monte Carlo method, (T), 25:59108
  - dose rates in two-layered slab shields, semi-empirical representation of, 25:59117
  - dose to rabbits and rats, effectiveness of blood plasma-quenching effect for measuring whole-body, 25:58017
  - dosimetry in cobalt-60 contact therapy, performance of rate meters for, 25:58010
  - dosimetry in human phantom, isodose curves for whole-body, 25:58004
  - dosimetry in therapy, computer programs for, 25:58021
  - dosimetry in therapy, computer programs for, 25:58020
  - dosimetry of mixed neutrons and, thermoluminescent dosimeter for, 25:57849
  - dosimetry of, 1970 IAEA international glass dosimetry intercomparison for calibration of dosimeters for, 25:57838
  - dosimetry of, energy calibration of dosimeters for, 25:57859
  - dosimetry of, G--M detector for environmental, 25:57721 (AECL-3989)
  - dosimetry of, intercomparison of survey detectors for, 25:57782
  - dosimetry of, lithium fluoride--Teflon dosimeters for surface, 25:57837
  - dosimetry of, maintenance of electron equilibrium in calibration of dosimeters for, 25:57860
  - dosimetry of, performance of Fricke dosimeter for, 25:57862
  - dosimetry of, performance of silicon detectors for, 25:57850
  - dosimetry of, standard for design of pocket ionization chamber for personnel, 25:57830
  - dosimetry of, thermally stimulated exoelectron emission dosimeter for, 25:57836
  - effectiveness for sterilization of powders of dextran, 25:58160
  - effectiveness of cobalt-60, for therapy of human brain tumors, 25:58069
  - effectiveness of telecobalt, for therapy of uterine cervical carcinomas, 25:58070
  - effects on alkane glasses containing olefins, luminescent, 25:57463
  - effects on aqueous solutions of hydrogen--potassium amide, production of long-lived ammoniated electrons in, 25:57477
  - effects on bacteriophage phi X174, effects of oxygen, nitrogen, and thiourea on mutagenic, 25:57971
  - effects on bacteriophages, protective effects of versene against, 25:58032
  - effects on berry seed, cuttings, and entire plants, effects of dose and species on, 25:58151
  - effects on catalytic activity of iron in ammonia synthesis, 25:57444
  - effects on chemical and physical properties of dextran, dose dependence of, 25:58160
  - effects on chromosomes in seed of Crepis capillaris, effects of time of onset of mitosis on frequency of aberrant, 25:57968
  - effects on chromosomes of barley seed grown at high altitudes, effects of uv-deficient light conditions on frequency of aberrant, 25:57969
  - effects on chromosomes of fibroblasts and lymphocytes of children with Fanconi's anemia, aberrant, 25:57973
  - effects on chromosomes of medical personnel, effects of dose and dose fractionation on aberrant, 25:57972
  - effects on citric acid in nitric acid--strontium nitrate solutions, 25:57457 (ARH-2163)
  - effects on clathrate hydrates of cyclopropane, ethylene oxide, and propylene oxide, stability of radicals from, 25:57476
  - effects on corn, grain yield, and uptake of nitrogen and phosphorus from fertilizers and soil following seed exposure, 25:58154

XUM

effects on count and morphology of lymphocytes from chronic lymphocytic leukemia patients following extracorporeal exposure of blood, 25:58131 (CEA-CONF-1768)
effects on decoloration of textile dye solutions, synergistic effects of oxidants on, 25:57452
effects on density of leaf miner infestations on white oak shoots, effects of dose on, 25:58092
effects on development of Ceratitis larvae, ecdysone restoration following inhibitory, 25:58094
effects on disorientation of polymer molecules, 25:58417
effects on DNA and RNA stability and synthesis and on growth in Tetrahymena pyriformis, additive effects of dactinomycin concentration and dose on, 25:58091
effects on Drosophila, antagonistic effects of vibrations on mutagenic, 25:57953
effects on eggs of Ascaridia galli used for chicken immunization, 25:57946
effects on elastic precursor decay in lithium fluoride single crystals, 25:59126
effects on Escherichia coli, protective effects of ethylene glycol against, 25:58157
effects on Escherichia coli, sensitizing effects of formaldehyde and thimersol against, 25:58157
effects on frequency of somatic recombinations in chlorophyll mutants of tobacco, 25:57977
effects on frequency vs temperature characteristics of synthetic-quartz AT resonators, 25:57906
effects on frozen aqueous solutions of alkali halides, ESR studies of hydrogen atoms and hydroxyl radicals from, 25:57467
effects on gaseous carbon dioxide at high density, 25:57461
effects on gaseous ethylene in presence of 2-methylpropene, yields from, 25:57474
effects on high-purity germanium, donor--vacancy complexes formed in, 25:59133
effects on human bladder and rectum during therapy of gynecological neoplasms, effects of dose from cobalt-60 applicators on pathological, 25:58010
effects on human breast neoplasms, effects of post-surgical dose on therapeutic, 25:58071
effects on human breast neoplasms, pre-surgical therapeutic, 25:58073
effects on human epithelium following therapy for cervical tumors in relation to recurrance incidence, cytological and histological studies on, 25:58140
effects on hydrates of cyclic ethers, EPR studies on free radicals from, 25:57465
effects on incidence of single- and double-strand breaks in phi X-174 replicative form of DNA, effects of LET on, 25:57952 (LBL-28)
effects on intestinal and spleen colony formation and survival of mice, effects of oxygen on RBE for, 25:57997 (LBL-314)
effects on intestinal mucosa in mice, regeneration following pathological, 25:58111
effects on lactate dehydrogenase activity in serum and vaginal tissues of cervical cancer patients, effects of dose on, 25:57937
effects on low-density polyethylene, effects of antioxidants on thermooxidative degradation in, 25:57462
effects on magnetic thin-film recording systems, 25:57908
effects on metabolism of amino acids and sugars in pea and wheat plants and their offspring, 25:57931
effects on microfungal populations in litter of red oak, effects of dose on, 25:58150
effects on mitotic activity of cultured human cancer cells, additive effects of colchicine on, 25:58080
effects on nutrative properties of fish, 25:58162
effects on oogenesis and reproductive system of beet leafhoppers following exposure of adults and nymphs, 25:58093
effects on oxidation state of recoil phosphorus-32 from neutron-irradiated tripolyphosphate hexahydrate, 25:57495
effects on phospholipase A activity in lysosomes, microsomes, and mitochondria in Sticker sarcoma of dogs, 25:57940
effects on phosphorus metabolism in pea and wheat plants and in first and second filial generations, 25:57941
effects on photodeformation effects in heat-treated germanium, 25:59128
effects on polymer composites and metal--epoxy resins, 25:58416(R) (RLO-2098-2)
effects on polymerization of monomers under superdry conditions, 25:57450 (ORC-3667-1)
effects on polymerization of solid trioxane, kinetics of, 25:57453
effects on polymerization of styrene in carbon tetrachloride or hexachlorobutadiene solutions, effects of additives on, 25:57454
effects on potassium antimonate and sodium hexafluorantimonate, ESR spectra of radicals from, 25:57445
effects on potassium bicarbonate single crystals at 77°K, ESR study of free radicals induced by, 25:57471
effects on rat tibia, effects of dose on neoplastic and pathological, 25:58102
effects on serum content of immunoglobulins in swine, 25:58104
effects on silicon carbide resistors, (E), 25:57903
effects on sodium chloride crystals after electric field treatment, kinetics of F-center growth in, (E/T), 25:59164
effects on spleen weight in mice, effects of dose fractionation on whole-body cobalt-60, 25:58108
effects on sprouting of potatoes during storage, 25:58159
effects on structure of sodium--tellurium glasses, EPR studies on effects of metal oxide additives on, 25:57447
effects on sunflower seeds, effects of variety on, 25:58148
effects on survival of Azotobacter chroococcum, effects of cell age and concentration on, 25:58156
effects on survival of chromium-51-labeled human erythrocytes in vivo following exposure in vitro, 25:58136
effects on ultrastructure of medullary tissue of rat brain, effects of dose on, 25:58118
effects on valence distribution of ion-implanted sulfur-35 in sodium chloride crystals, 25:57503
effects on water, effects of thallium sulfate on yields from, 25:57472
emission from mixed plutonium isotopes, scintillation spectrometer measurement of, 25:57998 (NIRS-Pu-8)
emission from NP 0532, upper limits for pulsed, (E), 25:58542
emission from pulsar--nebula complex, time-dependent transient, (T), 25:58550
fluence and flux density measurement of low-energy, germanium detector for, 25:57768
intensity of 0.3- to 2.7-MeV cosmic, (E), 25:58836
intensity of 0.511-MeV cosmic, during epoch of meteor streams, (E), 25:58836
intensity of cosmic primary, in vicinity of Earth, (E), 25:58831
intensity of cosmic, Cosmos-135 measurements of, (E), 25:58835
measurement of seabed, development of equipment and method for in-situ, 25:57586
monitoring in Indian soils during 1964 to 1970, 25:57567
monitoring of atmospheric, following Schooner Event, 25:57574 (PNE-524)
reactions (γ,f) with thorium-232 near threshold energy, angular distribution for, (E), 25:59786
reactions with air, scintillation induced by, 25:59119
spectra at balloon altitudes of cosmic, between 0.7 and 4.5 MeV, (E), 25:58832
spectra from decay of radioisotopes, tables of, 25:59785
spectra from neutron capture, high-count rate two-parameter system for measurement of, 25:57806
spectral characteristics of 0.3- to 2.7-MeV cosmic, (E), 25:58836
spectral characteristics of cosmic, Cosmos-135 measurements of, (E), 25:58835
use for therapy of lung carcinomas, review of complications and effectiveness in, 25:58137
use in radiographic quality control, efficiency of method for, 25:57696

GAMMA-RAY ASTRONOMY
research between 1962 and 1970 in, (E), 25:58533

GAMMA SOURCES
characteristics of radiometric testing equipment, effects on defect detection, 25:57701
determination in urine, methods used at CNEN for, 25:57347 (RT/PROT-(71)9)
fabrication for radiography, standard for, 25:57665
preparation and properties of cobalt-57, for Moessbauer studies, 25:59203
shielding for radiography, standard for, 25:57664
use with neutron source in method for measuring fluid flow, 25:57667(P)

GAMMA SPECTROMETERS
coincidence techniques using lithium-drifted germanium--thallium-activated sodium iodide pair, for high-energy gamma rays, 25:57804
data from scintillation, response matrix for analysis of, 25:57795(T) (LB/G-3075)
design and performance of Compton, for intense pulsed sources in high-level backgrounds, 25:57813
fabrication and testing of 60-cm^3 well-type lithium-drifted germanium, for activation analysis, 25:57805
fabrication and testing of high-purity p-type germanium, 25:57820
fabrication and testing of high-purity-germanium n--i--p detectors for, 25:57811
fabrication and testing of well-type lithium-drifted germanium, with <5μ dead layer, 25:57799
fabrication and testing of, made from high-purity germanium, 25:57814
performance of germanium semiconductor, 25:57822
performance of whole-body, comparison of, 25:57823
preamplifiers for, application of pulsed feedback techniques to, 25:57812
testing of encapsulated lithium-drifted germanium, in liquid nitrogen, assembly for, 25:57800

GAMMA SPECTROSCOPY
spectra analysis in, computer methods for, 25:57810

XUM

- control system for gas turbines, 25:60073(P)
- magnetohydrodynamic, current and potential distributions at high magnetic field strengths, (T), 25:58844
- magnetohydrodynamic, distribution discontinuities in thin layers, 25:58850
- magnetohydrodynamic, energy equation and radiative transfer equation solutions in, 25:58851
- magnetohydrodynamic, mixed three-dimensional, in longitudinal field, (T), 25:59047

GAS TURBINE ENGINES
- performance of aircraft, radiographic methods for measuring dynamic, 25:57689

GASES
- conference on gas discharges, international, London, 9/70, 25:59009
- electric discharge in, computer simulation of breakdown potential, (E/T), 25:59004
- electron scattering by magnetic, cross-section formulas for polarized-, 25:58687
- heating by stabilized electric arcs at high pressures, calculation of characteristics of, 25:59059
- hydrogen-atom and -ion (H^-) reactions with, summary of experimental data on electron capture and loss in, 25:58742
- ion reactions with, review of excited-atom formation by charge exchange in, 25:58691
- kinetic theory of, polynomial expansion method for problems involving relativistic Maxwellian distribution, 25:59053
- neutron scattering spectrum of ideal and real, theory of, 25:59678
- physics of ionized, Yugoslav summer school in July 1970 on, 25:58739
- proton reactions with, summary of experimental data on electron capture and loss in, 25:58742
- reactions of atomic beams of, with hot solid surfaces, harmonic-model analysis of, 25:58690
- sorption on tungsten in strong electric field, field-ion microscopic study of, 25:58246
- spectra of, heated by hard uv or energetic particles, (T), 25:58629
- transport of dilute, with internal degrees of freedom, generalized master equation for, 25:59224

GASTROINTESTINAL TRACT
- californium-252 distribution in rat, following intraperitoneal injection, 25:57922

GELATIN
- radiation effects on aqueous solutions of, at -170 to 25°C, 1-MeV electron, 25:57443

GENES
- radiation effects on behavior of parthenogenetic wasp, x, 25:57962

GENTILLY POWER REACTOR
- control systems of, design characteristics of, 25:59929
- operations for, 25:59929

GEOMAGNETIC FIELDS
- activity index in, relation to Pi2 micropulsation occurrences observed at high latitude, (E), 25:58903
- activity of, correlation with interplanetary plasma and magnetospheric parameters, (E/T), 25:58886
- activity of, effect on electron drift in equatorial electrojet region, (E/T), 25:58905
- effect on elf and vlf radio-wave propagation under daytime ionosphere near 1 to 4 kHz, (T), 25:58873
- effect on radio-wave reflection and transmission in ionosphere, numerical calculations of, (T), 25:58869
- interaction with charged particles, processes of, (E/T), 25:58910
- model of, solar proton trajectory calculations in Williams and Mead, (E/T), 25:58861
- pulsations in, relation of Pi2 occurrences to magnetic bays and magnetic activity, (E), 25:58903
- theory for nearly symmetric kinematic and hydromagnetic dynamos in, (T), 25:58846
- variations during quiet and disturbed days, H component for 1964 daily, (E/T), 25:58874
- variations in, correlation of electric currents in Earth with daily, lunar, and disturbance, (E/T), 25:58889

GERBILS
- thyroid gland function in, use of iodine-131 in studies of, 25:57915

GERMANIUM
- effects on complexonometric determination of rare earths, 25:57317
- electron emission induced by rare-gas ions at 10 to 30 keV on monocrystals of, 25:59175
- electron reactions with, secondary emission from, 25:58683 (FRNC-TH-49)
- electron secondary emission induced by rare-gas ions at 10 to 30 keV, angular dependence of, (E/T), 25:59146
- etching of, mechanism studies on, 25:58244
- lithium precipitation centers in crystal of, effects of oxygen vacancy clusters on, 25:57735
- oxidation in air, water, and hydrogen peroxide, 25:58244
- pair formation in, temperature dependence of average energy for electron--hole, 25:57739
- preparation of high-purity crystals of, for semiconductor detectors, 25:57787
- proton dechanneling in, (E/T), 25:59130
- purification of crystals of, using lead getter, 25:57736
- radiation damage regions in, crystallinity of fission-neutron and ion-, (E/T), 25:59140
- radiation effects on infrared absorption by, relations of displaced atoms and radioinduced impurities with in-pile, 25:58343
- radiation effects on photodeformation effect in heat-treated n- and p-type, γ, 25:59128
- radiation effects on thermal conductivity in n- to p-type conversion region of antimony-doped, 4-MeV electron, 25:59134
- radioinduced defects in n- and p-type, annealing and energy level spectrum of 660-MeV proton, 25:59159
- radioinduced defects in n-type, at 5°K, radiation annealing 1.1-MeV electron, 25:59132
- radioinduced donor--vacancy complexes in high-purity, effects of heat treatment of gamma, 25:59133
- radioinduced electric potential in monocrystals in magnetic field, α- and β-, 25:59143
- reactions of recoil atoms of, research progress on, 25:57487(R) (COO-1713-25)

GERMANIUM ALLOYS AND SYSTEMS
- Al--Ge--Nb, properties of superconducting, 25:58948
- As--Ge--Te, radiation effects on crystal structure of glass-forming chalcogenide of, fast neutron, 25:58419
- Ge--Si-base, radioinduced disorder in p-type, Rutherford-backscattering study of helium-ion, 25:59136

GERMANIUM ISOTOPES Ge-68
- energy levels from arsenic-68 decay, spin--parity assignments for, (E), 25:59747

GERMANIUM ISOTOPES Ge-70
- proton reactions (p,3n) at 30 to 55 MeV, cross sections for, (E), 25:59747

GERMANIUM ISOTOPES Ge-76
- neutron reactions (n,2n) at 14.7 MeV, isomer ratio in, (E), 25:59766

GERMANIUM OXIDES
- radioinduced intrinsic and impurity defects in, ESR study of, 25:59174

GLASS
- analysis for boron by neutron activation and prompt γ ray measurement, 25:57369(T) (RFP-Trans-83)
- book: Radiation Effects on Glass and Ceramics, in Russian, 25:59147
- properties of radiation-shielding, 25:58421
- radiation effects on structure of sodium oxide--tellurium oxide, EPR studies on effects of metal oxide additives on γ, 25:57447
- radioinduced luminescence of olefin-containing alkane, γ, 25:57463
- reactions of foamed, with fluorine, 25:57619 (RFP-1739)
- uses in nuclear engineering and research, 25:58421

GLASS TEXTILES
- glass fibers--polyethylene, radiation effects on mechanical properties and creep resistance of composites of, gamma, 25:58416(R) (RLO-2098-2)
- glass fibers--polysulfones, radiation effects on composites of, gamma, 25:58416(R) (RLO-2098-2)

GLOVE BOXES
- materials for, reactions with fluorine, 25:57619 (RFP-1739)

GLOW DISCHARGES
- plasma acceleration in toroidal, in radial magnetic fields, (E/T), 25:59002

GLUTAMIC ACID
- radiation effects on metabolism in pea and wheat plants and their offspring, gamma, 25:57931

GLYCINE
- radiation effects on metabolism in pea and wheat plants and their offspring, gamma, 25:57931

GLYCINE, N-(CARBOXYMETHYL)-N'-(2-HYDROXYETHYL)-N,N'-ETHYLENEDI-
- complexes with rare earths, dissociation constants for, 25:57537

GOLD
- abundance on surfaces of peculiar A stars, (E/T), 25:58462
- determination by extraction using quinolinol melt and spectrography, 25:57312
- determination simultaneously with selenium and tellurium in water by neutron activation, 25:57370
- helium-ion stopping power calculation for channeling in, 3-MeV, 25:59129
- ionization cross sections of, measurement of, 25:58344(R) (LA-4693)
- layer thickness measurement on vanadium by deuteron backscatter, 25:59640 (CONF-711002-, pp 272-82)
- preparation of radiation targets of, by argon ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
- preparation of thin-film targets of, using Zapon temporary backing, 25:59639 (CONF-711002-, pp 134-43)
- proton stopping power at 20 to 1000 keV of, electronic, (T), 25:59124
- separation from platinum by solvent extraction using triphenylguanidinium chloride, 25:57554

GOLD ALLOYS AND SYSTEMS
- Ag--Au-base, radioinduced crowdions in, comments on evidence for electron, 25:59162
- Ag--Au-base, radioinduced crowdions in, stabilization of electron, (T), 25:59153
- Au--Pd--Te, superconductivity in simple cubic intermetallic (Au/sub 1-x/Pd/sub x/)Te_2, 25:58928 (CALT-822-37)

  Au-base--Gd, electron spin resonance spectra in single crystals of, crystal-field fine structure in, 25:59192
GOLD CHLORIDES
  effects on nitrification by Nitrobacter agilis in soil suspension, 25:57401
GOLD ISOTOPES Au-197
  neutron capture at 30 keV to 1.4 MeV, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801
  photofission at 0.1 to 5 GeV, giant resonance in yields and integral cross sections for, (E), 25:59794
  photon reactions (γ,n) with, energy dependence of yield for, (E), 25:59815
  proton reactions (p,γ) at 4 MeV, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801
GONADS
  radiosensitivity of hermaphrodite, of Asterina gibbosa, studies on differential, 25:58090
GRANITES
  uranium distribution in, from Central Kazakhstan, statistical analysis of, 25:57583
GRAPHITE
  analysis of pyrolytic, for lanthanum, neodymium, tantalum, and tungsten by neutron activation and counting of delayed β and γ coincidences, 25:57389
  crystal lattice dynamics in, 25:58168 (ORNL-4676, pp 139-233)
  density of, effects of processing method on, 25:58168 (ORNL-4676, pp 139-233)
  diffusion of gaseous fission products from, mechanism for, 25:58367 (EUR-4327)
  diffusion of molten zirconium in, at 1860 to 2250°C, effects of graphite lattice parameters on, 25:58245
  fission product deposition in MSRE, evaluation by Auger electron spectroscopy, 25:58168 (ORNL-4676, pp 139-233)
  performance as lubricant for deep drawing of nickel alloys and stainless steel, 25:58195
  permeability of, effects of pyrolytic carbon sealing on, 25:58168 (ORNL-4676, pp 139-233)
  preparation of thin foils of, for electron microscopy, ion beam thinning method for, 25:58350 (RD/B/N-2020)
  properties of molded, effects of coke starting mixtures on mechanical, physical, and thermal, 25:58366 (CEA-CONF-1820)
  radiation effects on dimensions of test specimens of, in-pile, 25:58168 (ORNL-4676, pp 139-233)
  radiation effects on dimensions of, neutron, 25:58366 (CEA-CONF-1820)
  radiation effects on dislocations in, 200-kV electron, 25:58168 (ORNL-4676, pp 139-233)
  radioinduced paramagnetic center in, specific heat--magnetic field study of neutron, 25:59148
  stability of MSRE moderator elements of, evaluation of, 25:58168 (ORNL-4676, pp 139-233)
GRAPHITE BROMIDES
  crystal structure of lamellar, 25:58404
GRAPHITE SYSTEMS
  B--graphite, diffusion of helium from irradiated, at 200 to 300°C, 25:58378
  epoxy--graphite, tensile properties of fiber-reinforced composites of, 25:58382
  graphite--plastics, properties of continuous filament reinforced, for use in space, 25:58422
GRAVITATION
  constant of, decrease in, (T), 25:58667
  formalism for, Lorentz covariant and second quantized, 25:59547
  graviton mass in field theory of, 25:59601
  Lagrangians in, solutions of equations with quadratic, (T), 25:59603
  predictions of Deser--Laurent theory of, 25:59585
  space--time in, measurement method for Riemannian structure of, 25:59608
  theory for, classical field deformation of Poincare group for space--time curvature in, 25:59531
  theory of, Lorentz-invariant scalar, 25:59590
  variational principle of Einstein, general formulation of tetrad, 25:59600
GRAVITATIONAL FIELDS
  effects of solar, on radio-wave deflection, (E), 25:58662
  effects on Carnot cycles, (T), 25:58673
  energy density for neutrino--, positive, 25:59589
  particle quantization in external, (T), 25:59599
  radiation scattering in linearized Einstein--Maxwell, (T), 25:59606
  theory for system of electromagnetic field, massless scalar field and, solutions in, (T), 25:59587
  theory for, Newman--Penrose formalism comparison with classical, 25:59593
GRAVITATIONAL RADIATION
  detection of high-frequency, review of, (E), 25:59604
  detection of, survey of research in, (T), 25:59607
  emission from supermassive disks undergoing fragmentation, (T), 25:58668
  graviton interactions in Lorentz covariant and second quantized formalism, 25:59547
  red shift in, equivalence with temperature shift in Moessbauer effect for, (T), 25:59596
  sources of high-frequency, review of, (E), 25:59604
GRAVITY WAVES
  propagation in ionospheric F2 layer, TID excitation from internal acoustic-, (E/T), 25:58872
GROSSWELZHEIM SUPERHEAT REACTOR
  fuel elements for, welding methods for fabrication of, 25:58205
GROUND
  motion from seismic events, method for calculating linear dynamic response of buildings to, 25:57592 (JAB-99-70)
  motion induced by explosions, finite difference method for calculation of, 25:57594 (UCRL-73369)
  motion of Amchitka Island, from underground nuclear explosions, method for prediction of, 25:57602 (SC-RR-69-376)
GROUP THEORY
  Lie algebra of SO(n), polynomial identity for vector operators for, 25:59538
  permutation degeneracy in four electrons in quantum mechanics, (T), 25:59235
  Poincare group deformation by classical fields, 25:59531
  Poincare group for elementary particle interactions, lightlike, continuous-spin, and spacelike representations of, 25:59532
  Poincare group for timelike, lightlike, and spacelike momenta for partial-wave analysis of amplitudes of interactions of spinning particles, 25:59533
  review for particle symmetries, 25:59530
  scattering amplitudes in, structure of generalized Veneziano, 25:59628
  topological group deformation in, 25:59531
GULF OF MEXICO
  uranium geochemistry in, 25:57587
GUNDREMMINGEN POWER REACTOR
  maintenance during July 1971, 25:59914 (TID-25818)
  operation during July 1971, 25:59914 (TID-25818)

H

H.B. ROBINSON POWER REACTOR, UNIT 2
  construction of, request for not suspending permit for, 25:59951 (DOCKET-50261-74)
HI REGIONS
  distribution in central region of Galaxy, (E), 25:58652
  distribution in Milky Way, (E), 25:58651
  helium-ion abundance in, (E/T), 25:58630
  hydroxyl (OH) transition in, excitation temperatures of 18-cm, (E), 25:58560
HII REGIONS
  distribution in Milky Way, (E/T), 25:58528
  mapping at 2.695 GHz of M17 and S2 L14MO P12, 25:58557
  relation to Wolf--Rayet stars, (E), 25:58477
  spectra of W49 A, detection of anomalous interstellar recombination line in, (E), 25:58563
HADRONS
  interactions and properties of, (E/T), 25:59326
  interactions at high energies in quantum field theory, quasi-potential theory of, 25:59442
  interactions at high energies, two-particle correlations in inclusive strong, 25:59436
  interactions at high energies, two-Reggeon exchange contribution to amplitudes of, (T), 25:59618
  interactions at large momentum transfer, properties of inclusive, 25:59444
  interactions of composite, resonance model for electromagnetic, 25:59386
  interactions of, bilocal field operators for, 25:59583
  interactions of, π^0 electroproduction as test of dip mechanisms in, (T), 25:59346
  interactions of, scaling law in dual-resonance model for high-energy deep inelastic, (T), 25:59428
  interactions with electrons at high energies, suppression of electromagnetic corrections to, (T), 25:59372
  interactions with hadrons at high energies, statistical thermodynamic models for asymptotic form of transverse-momentum distribution of secondary particles from, (T), 25:59427
  interactions with hadrons, parton model for heavy lepton production in, 25:59401
  interactions with hadrons, point-source static model for renormalized field product for Bjorken limit and Ward identity for, (T), 25:59564
  interactions with leptons, parton model for semi-inclusive, 25:59401
  interactions with photons, hadron electrodynamics in resonance model for, 25:59386
  interactions with photons, parity rule and helicity conservation in rho^0 production in, 25:59384
  mass spectra and bound states in quark model, 25:59426
  model for, atoms with magnetic charges as, 25:59447
  model of, scale invariance breaking and Regge trajectories in dyon, 25:59430
  production in deep inelastic e + e interactions in colliding beams, differential cross sections for, (T), 25:59371
  production in deep inelastic e + γ interactions in inelastic e + e interactions, (T), 25:59333 (JINR-E2-6036)
  production in e + e and $e^+ + e^-$ interactions, Regge-pole-theory prediction of scaling in, (T), 25:59376
  production in e + p interactions, wee parton model for

XUM

  single, 25:59387
  production in $e^+ + e^-$ and virtual $\gamma + \gamma$ interactions in colliding beams, differential cross sections for hadron and two-electron production in deep inelastic e + e interactions from total cross sections for, (T), 25:59371
  production in $e^+ + e^-$ interactions in colliding beams, contribution to total cross section from bremsstrahlung mechanism for differential cross section for, (T), 25:59375
  production in $e^+ + e^-$ interactions in crossed beams, Landau--Lifshitz process for cross sections for, (T), 25:59334 (LNF-71/14)
  production in p + p interactions at high energies, charge-conservation model for multiple, (T), 25:59512
  symmetry properties from asymptotic identification in local gauge theory, internal, 25:59545
HAFNIUM
  determination by spectrography, elimination of effect of sample composition on, 25:57330
  determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
  effects on electric properties of lanthanum boride, temperature dependence of, 25:59183
  effects on electric properties of lanthanum hexaboride, 25:59182
  preparation of radiation targets of, by argon ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
  separation from sulfate solutions obtained from zirconium ores by extraction with cyclohexanone solutions of thiocyanic acid, 25:57533
HAFNIUM ALLOYS AND SYSTEMS
  C--Cr--Fe--Hf--Mn--Mo--Nb--Ni-base--Si--Ti--Zr, radiation effects on mechanical properties of, relations of composition with thermal neutron, 25:58168 (ORNL-4676, pp 139-233)
  Hf--Nb, electric conductivity from 4 to 300°K, 25:58929 (FRNC-TH-72)
  Hf--Pt-base--Rh--Ti--W, hardness of crystallized, effects of annealing at high temperatures on, 25:57658(R) (ORNL-4723)
  Hf--U, liquidus and solidus curves for, calculations for, 25:58292
  Hf--Zr, liquidus and solidus curves for, calculations for, 25:58292
HAFNIUM CARBIDES
  machining of, effects of carbon content in corresponding ranges of homogeneity on electroerosion, 25:58356
HANFORD PRODUCTION REACTORS
  protection systems for, description of data acquisition and processing equipment and procedures for, 25:60208
HASTELLOY C
  compatibility with irradiated cobalt-60 fuels at 850 to 1000°C, 25:57654(R) (DP-1279)
  testing of fuel capsules of, at 1000°C, results of long-term, 25:57654(R) (DP-1279)
HASTELLOY N
  compatibility with Haynes 25 alloy in fused sodium fluoroborate mixture at 460 to 605°C, 25:58169 (ORNL-TM-3488)
  corrosion by high-pressure high-temperature steam, 25:58168 (ORNL-4676, pp 139-233)
  corrosion by sodium fluoride--sodium fluoroborate coolant salts at high temperatures, 25:58168 (ORNL-4676, pp 139-233)
  corrosion of modified, by molten MSRE fuel salts, 25:58168 (ORNL-4676, pp 139-233)
  radiation effects on mechanical properties of, relations of hafnium, niobium, and titanium additions with neutron, 25:58168 (ORNL-4676, pp 139-233)
  radiation effects on MSRE control rod thimble of, in-pile, 25:58168 (ORNL-4676, pp 139-233)
  stability of rods of, from MSRE sampling assembly, 25:58168 (ORNL-4676, pp 139-233)
  weldability of hafnium- and zirconium-modified, using Hastelloy N weld filler, 25:58168 (ORNL-4676, pp 139-233)
HASTELLOY X
  compatibility with irradiated cobalt-60 fuels at 850 to 1000°C, 25:57654(R) (DP-1279)
  joining to high-strength materials by continuous seam diffusion bonding, 25:58201
  oxidation at 1000 to 1125°C in air, 25:57654(R) (DP-1279)
  testing of fuel capsules of, at 1000°C, results of long-term, 25:57654(R) (DP-1279)
HAYNES 25 ALLOY
  compatibility with Hastelloy N in fused sodium fluoroborate mixture at 460 to 605°C, 25:58169 (ORNL-TM-3488)
  compatibility with irradiated cobalt-60 fuels at 850 to 1000°C, 25:57654(R) (DP-1279)
  testing of fuel capsules of, at 1000°C, results of long-term, 25:57654(R) (DP-1279)
HAYNES 188 ALLOY
  oxidation at 1000 to 1125°C in air, 25:57654(R) (DP-1279)
HEART
  radiation effects on human, following therapy for thoracic diseases, 25:58147
  radiation injuries to laboratory animal, pathology of, 25:58122
  scintigraphy of myocardium of dog, evaluation of cesium-129 and potassium-43 for, 25:58041 (UCLA-12-837)
HEAT
  storage methods for, during power plant reduced load operation, 25:60143(P)
HEAT EXCHANGERS
  design and fabrication of improved helical-type, 25:57630(P)
  performance of tubular, effects of twisted tapes on thermal, 25:57643
  stability of materials in MSRE, evaluation of, 25:58168 (ORNL-4676, pp 139-233)
HEAT EXCHANGERS (GAS-LIQUID)
  design characteristics of secondary, for gas cooled reactors, 25:60074(P)
HEAT EXCHANGERS (LIQUID-LIQUID)
  design evaluation of sodium intermediate reactor, using austenitic or ferritic steel, 25:57614 (KFK-1387)
  design problems with liquid sodium cooled fast reactor intermediate, 25:60077
HEAT PIPES
  testing of lithium, research progress on in-pile, 25:57615(R) (LA-4746)
  use in nuclear thermionic fuel elements, 25:60199(P)
HEAT-RESISTING ALLOYS AND METALS
  abrasion resistance of, comparison of gas-borne corundum and diamond wheels for testing, 25:58386
  machining of cylindrical apertures in, by electroerosion, 25:58193
HEAT SOURCES
  materials for, research progress on development of, 25:57654(R) (DP-1279)
HEAT TRANSFER
  analysis in reactors, book on, 25:60222
  burnout in transient boiling, (E/T), 25:57647
  coefficients of forced-convection, for tubular heat exchangers, effects of twisted tapes on, 25:57643
HEAT TRANSFER SYSTEMS
  spinning disks for cooling pond, evaluation of, 25:60023
HEATED EFFLUENTS
  effects on environment of U.S. of power reactor, 25:60001
  effects on environment of U.S. power reactor, 25:60002
HEATERS
  testing of high-flux, in flowing sodium, 25:58163(R) (AI-AEC-12859)
HELIUM
  abundance in chromosphere and solar prominences, (E), 25:58602
  abundance in O and B stars, (T), 25:58472
  abundance in planetary nebulae, (E/T), 25:58446
  burning in 10 solar mass Population I stars, (T), 25:58465
  burning in stars, element production from, (E/T), 25:58508
  conference on, at very low temperatures, Grenoble, France, 3/70, 25:58913
  dielectric insulator properties for superconducting power cables, 25:58950
  diffusion from irradiated boron--graphite at 200 to 300°C, 25:58378
  effects in combination with sodium on stress rupture of Types 304 and 316 stainless steel at 900 to 1200°F, 25:58167(R) (AI-AEC-12987)
  effects of high-temperature, on mechanical properties of Type 304 and 316 stainless steel, 25:58163(R) (AI-AEC-12859)
  electric discharges in alkali-metal-seeded, properties of high-current, 25:59023
  electron reactions with, cross sections for ionization in, (T), 25:58738
  electron reactions with, excitation in, (E), 25:58741
  electron reactions with, model potentials for, 25:58772
  energy level populations in low-current arcs, (E), 25:59017
  energy levels of, calculation using Hulthen orbital approximations, 25:58713
  energy levels of, extension of Hylleraas expansion for ground-state, 25:58795
  helium-ion reactions with, energy spectra of electrons from, (T), 25:58733
  hydrogen-ion (H_2^+ and H_3^+) reactions at 10 to 130 keV with, excitation of autoionizing levels in, (E), 25:58779
  interaction with solar wind, helium$^+$ ion abundance from photoionization of interstellar, (E/T), 25:58855
  ionization in lunar atmosphere and associated properties, 25:58679
  nucleosynthesis in pulsating massive main-sequence stars, (T), 25:58434
  phase diagram for, in interior of Jupiter and Saturn, (E), 25:58675
  phonon interactions in liquid, (T), 25:59204
  plasma of, metastable densities in neutron environment, (E/T), 25:59003
  plasma of, production of quiescent, in skipping magnetic fields, (E), 25:59055
  positron annihilation in, time dependence of, (E), 25:58725
  production by neutron reactions with elements, evaluation

of in-pile, 25:58163(R) (AI-AEC-12859)

- properties of, upper and lower bounds to expectation values for, (T), 25:58810
- proton reactions at 10 to 130 keV with, excitation of autoionizing levels in, (E), 25:58779
- radioinduced production in alloys and metals by nuclear reactions, 25:58166(R) (AI-AEC-12980)
- radioinduced production in alloys and metals by nuclear reactions, 25:58167(R) (AI-AEC-12987)
- radioinduced production in cladding materials, neutron, 25:58336
- radioinduced production in silver foils, fast neutron, 25:58334
- radioinduced release from neutron-irradiated nickel, 25:58335
- reactions at 5 to 300°K between metastable 2^3S atoms of, total cross sections for metastable destruction and ionization in, 25:58731
- reactions between atoms of, at 145 to 300 eV, energy spectra of ionization products from, (E), 25:58764
- scattering by lithium fluoride (001) surface, (E), 25:58694
- scattering by molecules, velocity dependence of total effective cross sections for, 25:58782
- solubility in molten lithium beryllium fluorides, 25:57298 (ORNL-4676, pp 73-138)
- solubility in sodium, 25:58387(R) (ANL-7823)
- spectra in O and B stars, (T), 25:58472
- spectra of dense plasma of, contours and intensity of, 25:59016
- spectra of, in solar prominences, (E), 25:58604
- structure of He--quark molecules, electronic, 25:59344
- wave functions for excited and ground states of, 25:58710
- wave functions for excited states of, Hulthen transform functions in approximation of, 25:58713

HELIUM HYDRIDES

- binding energy for excited states of ionized, calculation using exchange perturbation theory, 25:58702

HELIUM IONS

- abundance in H I regions, (E/T), 25:58630
- channeling in gold at 3 MeV, stopping-power calculation for, 25:59129
- effects on intestinal and spleen colony formation and survival of mice, effects of oxygen on RBE for, 25:57997 (LBL-314)
- effects on metal foils at MeV ranges, design of low-temperature facility for studies of, 25:57620 (RISO-204)
- effects on silicon and silicon--germanium at 275 and 1610 keV, Rutherford-backscattering study of disorder induced in, 25:59136
- effects on uranium carbide fuel pellets at cyclotron energies, 25:58163(R) (AI-AEC-12859)
- electron recombination with molecular, effects of metastable--metastable collisions on, (E), 25:58714
- level populations for, in gaseous nebulae, (T), 25:58516
- reactions with aluminum at 45 to 90 keV/amu, helium-isotope dependence of cross sections for K-shell ionization in, (E), 25:58776
- reactions with copper, molybdenum, and silver at 45 to 90 keV/amu, helium-isotope dependence of cross sections for L-shell ionization in, (E), 25:58776
- reactions with helium, energy spectra of electrons from, (T), 25:58733
- reactions with oxygen molecules at 100 eV to 4 keV, energy losses and energy-level transitions in, (E), 25:58753
- reactions with tungsten at 45 to 90 keV/amu, helium-isotope dependence of cross sections for M-shell ionization in, (E), 25:58776
- scattering from amorphous tungsten oxide surface at 275 keV, spectra of low-angle, (E/T), 25:58689

HELIUM ISOTOPES He-3

- binding energy of, effect of charge asymmetric potentials on, (T), 25:59701
- Boltzmann transport equation for quasi particles in liquid, derivation of hydrodynamics from, 25:59215
- deuteron reactions (d,n) with, formalism for polarized particles in, (T), 25:59837 (LA-4492)
- forces in liquid, Landau theory for two-body effective, (T), 25:59850
- meson (μ^-) capture by, elementary particle treatment of, (T), 25:59397
- neutron capture at 0.025 eV, cross sections for two-quantum radiative, (T), 25:59527
- particle reactions at high energies, relativistic Feynman graphs in momentum representation for method for calculating amplitudes of, (T), 25:59528
- proton reactions (p,pd) at 35 MeV, effect of neutron pickup on quasi-free scattering, (E), 25:59702
- reactions (He-3,$\alpha\gamma$) with silicon-28 at 8.2 MeV, spectra from, (E), 25:59751
- reactions (He-3,d) and (He-3,t) with lithium-7 at 15 MeV, deuteron and triton spectra from, (E), 25:59731
- reactions (He-3,d) with strontium-88 at 24.78 MeV, DWBA analysis of differential cross sections and spectrum from, (E), 25:59750
- reactions (He-3,p) with odd--even nuclei, isospin effects on angular distributions from, (T), 25:59741
- reactions (He-3,t) with titanium-46 at 37.7 MeV, DWBA analysis including tensor force of, (E), 25:57901
- reactions (He-3,tp) and (He-3,He-3p) with deuterium at 27 MeV, PWBA analysis of coincidence spectra from, (E/T), 25:59694
- role in tritium beta radioinduced death of mammalian cells, 25:58086
- scattering by A = 48 to 64 nuclei at 29 to 35 MeV, optical-model analysis of differential cross sections for elastic, (E), 25:59769
- He-3--He-4, current flow in liquid, surface-state lifetimes and, 25:58911
- He-3--He-4, light scattering by superfluid mixtures, 25:58916
- He-3--He-4, mass and spin diffusion near lambda line in dilute mixtures, 25:58926
- He-3--He-4, sum rules for binary solution and effective interactions between helium-3 quasiparticles in superfluid helium-4, 25:58924
- He-3--He-4, thermal capacity of liquid, at lambda transition, 25:58919

HELIUM ISOTOPES He-4

- characteristic properties of superfluid, (T), 25:58918
- critical phenomena in liquid, phenomenological theory on, 25:58912
- critical velocities in superfluid flow through pinholes, (E), 25:58921
- current flow in liquid, surface-state lifetimes and, 25:58911
- dissipation in flowing superfluid film, potential-probe measurements of, 25:58925
- electron scattering by, analysis using Brueckner and Jastrow methods, (T), 25:59704
- energy levels of, fine structure interval 2^3P_0--2^3P_1 in atomic, (E), 25:58720
- flow dissipation equation in liquid II, 25:58927
- hydrodynamics and size effects in superfluid, (T), 25:58915
- light scattering by superfluid, 25:58916
- meson (π^-) scattering by, contribution of multiple scattering to total cross section for, 25:59524
- meson (π^+) scattering by, contribution of multiple scattering to total cross section for, 25:59524
- nuclear center-of-mass coordinate in Block--Horowitz theory for, (T), 25:59832 (JINR-E4-5890)
- phase coherence in superfluid, (T), 25:58914
- photon reactions (γ,d) with, dispersive calculation using Omnes--Muskhelishvili equation of cross sections for, (T), 25:59698
- photon scattering by, analysis for double scattering and glory effects in Compton, (T), 25:59703
- properties of ions and vortices in, (T), 25:58917
- surface second sound in liquid, 25:58931
- thermal capacity of liquid, at lambda transition, 25:58919
- transfer rate of liquid II film, dependence on pressure head, film height, and substrate, (E), 25:58922
- transport properties in superfluid, (T), 25:58914
- vortex in superfluid, core structure of quantized, (T), 25:58923
- He-3--He-4, current flow in liquid, surface-state lifetimes and, 25:58911
- He-3--He-4, light scattering by superfluid mixtures, 25:58916
- He-3--He-4, mass and spin diffusion near lambda line in dilute mixtures, 25:58926
- He-3--He-4, sum rules for binary solution and effective interactions between helium-3 quasiparticles in superfluid helium-4, 25:58924
- He-3--He-4, thermal capacity of liquid, at lambda transition, 25:58919

HELIUM ISOTOPES He-5

- energy level at 20 MeV from tritium (d,n) reactions, spin--parity assignments for, (T), 25:59706

HELIUM SYSTEMS

- He--N, ion production and loss processes in plasma of, (E), 25:59014
- He--Ne, atomic metastable densities in neutron environment, (E/T), 25:59003

HEMATOPOIESIS

- radiation effects on adult, neonatal, and weanling mouse, protective effects of tibial shielding against x, 25:58110
- radiation effects on mouse, effects of partial marrow shielding on x, 25:58124
- radiation effects on, in mouse spleen following transplantation of bone marrow, 25:58117

HEMOGLOBIN

- Moessbauer spectroscopy of, 25:60279(R) (NYO-3798-12)

HEXANE

- yields from γ radiolysis of gaseous ethylene in presence of 2-methylpropene, 25:57474
- $CaBr_2$--hexane, bromine-80m isomeric transition in, reactions of recoils from, 25:57494
- hexane--$HgBr_2$, bromine-80m isomeric transition in, reactions of recoils from, 25:57494
- hexane--$MgBr_2$, bromine-80m isomeric transition in, reactions of recoils from, 25:57494
- hexane--NH_4Br, bromine-80m isomeric transition in, reactions of recoils from, 25:57494
- hexane--$SrBr_2$, bromine-80m isomeric transition in, reactions of recoils from, 25:57494
- hexane--$ZnBr_2$, bromine-80m isomeric transition in,

  - reactions of recoils from, 25:57494
- HEXOKINASE
  - radiation effects on activity in brain and heart of rats, effects of adrenal hormones on x, 25:57929
- HIGH-TEMPERATURE LATTICE TEST REACTOR
  - physics measurements on molten salt reactor lattices in, 25:60015 (ORNL-4676, pp 21-72)
- HOLMIUM
  - complexes with HEDTA, dissociation constants for, 25:57537
  - oxidation potential for trivalent--tetravalent, 25:57437
  - spectra of, Zeeman effect in, (E), 25:58708
- HOLMIUM ALLOYS AND SYSTEMS
  - Dy--Ho, phase studies of, 25:58274
  - Dy--Ho--Y, phase studies of, 25:58274
- HOLMIUM IONS
  - energy levels of Ho II, 25:58708
- HOLMIUM ISOTOPES Ho-165
  - electron elastic scattering at 160.6 to 452.2 MeV by oriented, cross sections and electric charge distributions from, (E), 25:59796
  - neutron capture at 400 keV, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801
  - proton elastic scattering at 5 to 10 MeV by aligned, deformation parameter and spectra from, (E), 25:59788
- HORMONES
  - ecdysone, restoring effects on pupation of Ceratitis larvae following γ-radioinduced inhibition, 25:58094
- HORMONES, ADRENAL
  - cortisone, effects on ultrastructure of cells in thymus gland of mice, 25:58114
  - deoxycorticosterone acetate, radioprotective effects against ulceration in rabbit skin, x, 25:58036
  - effects on enzyme activity in brain and heart of x-irradiated rats, 25:57929
  - epinephrine, radiation effects on excretion of, by man, effects of ACTH on, 25:57938
  - epinephrine, radioimmunoassay in blood plasma, 25:57914
  - hydrocortisone, effects on survival of uv-irradiated KB cells, 25:58087
  - norepinephrine, radiation effects on excretion of, by man, effects of ACTH on, 25:57938
  - norepinephrine, radioimmunoassay in blood plasma, 25:57914
- HORMONES, PITUITARY
  - adrenocorticotropin, effects on excretion of catecholamines by man following irradiation, 25:57938
  - growth hormone, radioimmunoassay in dog plasma, 25:57909
- HORMONES, THYROID
  - triiodothyronine, effectiveness of iodine-131-labeled, for scintiscanning of human liver in comparison to colloidal gold-198 and iodine-131-labeled thyroxine, 25:58050
- HOT CELLS
  - camera for metallographic studies in, 25:57627
  - inert atmosphere systems for fuel examination, development of, 25:58344(R) (LA-4693)
- HUNGARY
  - radioisotopes in agriculture in, 25:57911
  - safety regulations for nuclear personnel in, evaluation of, 25:58027
- HUTCHINSON ISLAND POWER REACTOR, UNIT 1
  - construction of, request for not suspending permit for, 25:59983 (DOCKET-50335-20)
- HYDRAZOIC ACID
  - production and destruction in Purex Process, 25:57511 (BNWL-B-121)
- HYDROCARBONS
  - formation in early solar system by catalytic synthesis, (E/T), 25:58576
  - formation in early solar system by catalytic synthesis, (E/T), 25:58575
- HYDROCHLORIC ACID
  - analysis of analytical grade, for impurities by neutron activation, 25:57379
  - corrosive effects on joints of tantalum--titanium-base alloys at 90°C, 25:58176
  - solvent properties for mixed oxide fuels at high pressures, 25:58344(R) (LA-4693)
  - HCl--HNO_3, properties of etchant of, for uranium dioxide, 25:58244
- HYDROCYANIC ACID
  - rotational constants for, effects of deuterium on, 25:57423
  - spectra of, effects of carbon-13 and deuterium on ir, 25:57421
- HYDROGEN
  - abundance in Maffei 2, (E), 25:58632
  - determination by combustion in stream of nitrogen, oxidation, and gravimetry, 25:57349
  - determination in liquid sodium, development of on-line meter for, 25:60058(R) (ANL-7817)
  - determination in MSRE pump bowl gas, 25:57298 (ORNL-4676, pp 73-138)
  - diffusion through oxide-coated metals, 25:57298 (ORNL-4676, pp 73-138)
  - distribution of interplanetary, solar-cycle effects on cone, (T), 25:58578
  - effects of neutral, on collision broadening in stellar spectra, 25:58509
  - electron interactions in excited molecules of, sigma-pi, (T), 25:58711
  - electron reactions at 100 eV with molecular, cross section for Lyman α emission in, (E), 25:58729
  - electron reactions up to 350 eV with molecular, cross section for Lyman-α production by dissociative excitation in, (E), 25:58728
  - electron reactions with atomic, Glauber amplitudes for excitation of ns and np levels in, (T), 25:58766
  - energy levels in, semiclassical quantum theory calculation of shift of 2s, 25:59221
  - energy levels of atomic, beam--foil measurements of lifetimes of, 25:58722
  - energy spectra of bound-state atomic, finite- and infinite-dimensional local irreducible representations of O(3) symmetry for, (T), 25:59536
  - energy-level densities in ionized gas of, calculation using static screened Coulomb potential, 25:58721
  - energy-level transitions in molecular, moments for Lyman, as function of internuclear distance, (T), 25:58699
  - equation for atomic, formal equivalence to harmonic-oscillator equation, 25:59227
  - interactions of interstellar, with solar wind, (T), 25:58615
  - interactions with carbon and oxygen in interstellar medium, (E/T), 25:58623
  - iodine-ion reactions at 12 MeV with molecular, electron-capture and -loss cross sections for, (E), 25:58768
  - ionization fronts in interstellar, instability of weak, (T), 25:58627
  - ionization in lunar atmosphere and associated properties, 25:58679
  - level populations for, in gaseous nebulae, (T), 25:58516
  - lithium-ion reactions at 10 to 110 keV with molecular, polarization of Hβ line produced by dissociation and excitation in, (E), 25:58780
  - meson (μ^-) capture by gaseous, field theoretical basis for weak-interaction theory for, (T), 25:59397
  - monitoring in liquid sodium, development of diffusion tube detector for, 25:57877
  - neutron capture at 0.025 eV, cross sections and photon angular and spectral distributions for two-quantum radiative, (T), 25:59527
  - neutron coherent atomic scattering amplitudes for, (E), 25:59696
  - occurrence surrounding comets, Ogo-5 observations of, (E), 25:58574
  - phase diagram for, in interior of Jupiter and Saturn, (E), 25:58675
  - photon reactions with atomic, calculation of radial transition matrix elements for multi-, 25:58770
  - plasma of, potential breakdown in low-pressure discharges, (E), 25:59022
  - positron annihilation in, time dependence of, (E), 25:58725
  - positron reactions with atomic, theory of generalized variational bounds for positronium formation in, 25:58755
  - properties of atom of, use of factorization method and group theory in relativistic treatment of, 25:58821
  - proton reactions at high energies with atomic, total inelastic and charge-exchange cross sections for, (E), 25:58775
  - proton reactions at low energies with atomic, formal theory of, 25:58771
  - proton reactions with 2s atoms of, transition to ground state in, (T), 25:58746
  - proton reactions with atomic, Glauber amplitudes for excitation of ns and np levels in, (T), 25:58766
  - Rayleigh--Schroedinger perturbation theory for atomic, reasons for failure of, 25:58811
  - reactions of radiolytic, in argon--water systems, 25:57460
  - reactions with atoms of atomic, effects of orbital momentum on formation of highly excited hydrogen atoms in, (T), 25:58734
  - reactions with deuterium atoms of molecular, differential cross sections for deuterium hydride formation in, (E), 25:58778
  - reactions with gases of atomic, summary of experimental data on electron capture and loss in, 25:58742
  - reactions with hydrogen molecules and rare gas atoms of atomic, review of charge exchange in, (E), 25:58743
  - reactions with lithium, plans for studies on, 25:58387(R) (ANL-7823)
  - reactions with molybdenum trioxide and tungsten trioxide to prepare molybdenum and tungsten, 25:58189
  - reactions with sodium (3^2P) atoms of molecular, cross sections for excitation in, (E), 25:58778
  - scattering states of two-dimensional atomic, finite- and infinite-dimensional local irreducible representations of O(3) symmetry for, (T), 25:59536
  - separation from deuterium on cathode and diffusion sides of palladium--silver foils, factors for, 25:57538
  - separation from heavy water by isotope exchange with deuterium, 25:57545(P)
  - solubility in molten lithium beryllium fluorides, 25:57298 (ORNL-4676, pp 73-138)
  - sorption by delta-phase zirconium hydride at 650 to 800°C, kinetics of, 25:58373
  - spectra of atoms of, produced by γ-radiolysis of aqueous solutions of alkali halides, 25:57467

XUM

  spectral emission of extraterrestrial Lyman-α, Ogo-5 observations of, (E), 25:58574
  structure of H--quark molecules, electronic, 25:59344
  ultraviolet absorption spectra of molecular, Beutler--Fano shape in predissociation during measurement of, 25:58717
  wave functions for, study with noncompact group O(2,1), 25:58786
HYDROGEN IONS (H^-)
  reactions with gases, summary of experimental data on electron capture and loss in, 25:58742
HYDROGEN IONS (H_2^+)
  Green function for, exact, 25:58704
  reactions with helium at 10 to 130 keV, excitation of autoionizing levels in, (E), 25:58779
  reactions with oxygen molecules at 100 eV to 4 keV, energy losses and energy-level transitions in, (E), 25:58753
HYDROGEN IONS (H_3^+)
  density matrices for, configuration-interaction calculations of first-order, 25:58712
  reactions with helium at 10 to 130 keV, excitation of autoionizing levels in, (E), 25:58779
HYDROGEN PEROXIDES
  analysis of analytical grade, for impurities by neutron activation, 25:57379
  reactions with hexavalent and pentavalent neptunium in nitric acid solutions, 25:57414
HYDROGEN SYSTEMS
  Al--H, neutron diffusion constants for, (T), 25:59687
  H_2--KNH_2, radiolysis of aqueous solutions of, production of long-lived ammoniated electrons from γ, 25:57477
  H--V, hydride precipitation in, electron microscopy studies on, 25:58407
  H--W, heat transfer by aerosols of, measurement by extinction parameters at high temperatures, 25:57641
HYDROMAGNETIC WAVES
  interactions with plasma, reflection and transmission of, (T), 25:59093
HYDROXYL (HO)
  abundance in delta Scu, (E), 25:58479
  abundance in sunspots, (E/T), 25:58589
  radio emission from, associated with long-period variable stars, search for, (E), 25:58466
  spectra in nightglow, June-Dec., 1968 and June-Oct., 1969, (E), 25:58883
  spectra of, produced by γ-radiolysis of aqueous solutions of alkali halides, 25:57467
  spectral excitation of 18-cm transition of, in W12, temperature of, (T), 25:58560
  variations in night airglow observed at Calgary, (4-1) and (5-2) seasonal and diurnal, (E), 25:58902
HYDROXYLAPATITE
  precipitation of barium, radium, and strontium with, by isomorphous cocrystallization, 25:57418
HYPERONS
  decay in three-triplet and quartet model, urbaryon transitions for nonleptonic, 25:59423
  decays of, dispersion relations, current algebra, and PCAC for nonleptonic weak, 25:59409
  decays of, Regge theory for resonance contribution to s- and p-wave amplitudes for nonleptonic, 25:59420
  thermodynamics of stars composed of, (T), 25:58521
HYPERONS (Λ)
  decay $\Lambda \to p + \pi^-$ in hydrogen bubble chamber, lifetime and branching ratio for, (E), 25:59260
  decay of, violation of $\Delta I = {}^1/_2$ rule in nonleptonic, 25:59405
  decays of, Regge theory for resonance contribution to s- and p-wave amplitudes for nonleptonic, 25:59420
  interactions Λ + N, charge-symmetry breaking in, (T), 25:59515
  interactions Λ + p, cross sections for elastic, (T), 25:59525
  interactions $\pi + \Lambda \to \pi + \Lambda$ in Veneziano model, positive width and S-wave scattering length in, 25:59473
  lifetime of, (E), 25:59260
  magnetic moment from $\Lambda^0 \to p + \pi^-$ decay, (E), 25:59294
  production in four-body final states in $K^- + n$ interactions at 4.48 GeV/c in deuterium bubble chamber, (E), 25:59280
  production in $\pi^- + p \to \Lambda^0 + K^0$ interactions at 1.07 GeV/c, (E), 25:59294
HYPERONS (Ω^-)
  decay of, current algebra for p-wave amplitudes and $\Delta T = {}^1/_2$ rule predictions for nonleptonic, (T), 25:59398
  decay of, current algebra for rate predictions for semileptonic, (T), 25:59398
  decay $\Omega^- \to \Lambda + K^-$, current algebra for asymmetry parameter for, (T), 25:59398
  decay $\Omega^- \to \Xi + \pi$, current algebra for determination of Ω^- spin from asymmetry parameter for, (T), 25:59398
  decay $\Omega^- \to \Xi^-(\Xi^{*-}) + \gamma$, current algebra for rates for, (T), 25:59398
  production in $K^- + d \to K^- + \pi^- + 2p$ and $K^- + d \to K^- + \pi^+ + \pi^- + n + p$ interactions at 12.6 GeV/c, cross sections for, (E), 25:59283
  spin of, current algebra for asymmetry parameter for $\Omega^- \to \Xi + \pi$ decay for determination of, (T), 25:59398
HYPERONS (Σ)
  decay of, violation of $\Delta I = {}^1/_2$ rule in nonleptonic, 25:59405
  decays of, Regge theory for resonance contribution to s- and p-wave amplitudes for nonleptonic, 25:59420
  interactions Σ + N at low energies, parameters for, (T), 25:59525
HYPERONS (Σ^-)
  decay $\Sigma^- \to n + e + \nu$ in hydrogen bubble chamber, branching ratio for, (E), 25:59261
HYPERONS (Σ^0)
  production in four-body final states in $K^- + n$ interactions at 4.48 GeV/c in deuterium bubble chamber, (E), 25:59280
HYPERONS (Σ^+)
  decay $\Sigma^+ \to n + e + \nu$ in hydrogen bubble chamber, branching ratio for, (E), 25:59261
HYPERONS (Ξ)
  decay of, violation of $\Delta I = {}^1/_2$ rule in nonleptonic, 25:59405
  decays of, Regge theory for resonance contribution to s- and p-wave amplitudes for nonleptonic, 25:59420
HYPERONS (Ξ^-)
  production in $K^- + d \to K^- + \pi^- + 2p$ and $K^- + d \to K^- + \pi^+ + \pi^- + n + p$ interactions at 12.6 GeV/c, cross sections for, (E), 25:59283
HYPOPHOSPHITES
  effects on chemical state of recoil phosphorus-32 from neutron-irradiated tripolyphosphate hexahydrate, 25:57495

I

ICE
  analysis for selenium by neutron activation and radiochemical separation, 25:57394
  effects of dirty, on ultraviolet absorption by interstellar grains, (T), 25:58637
IMINO GROUP
  abundance in delta Scu, (E), 25:58479
  abundance in sunspots, (E/T), 25:58589
IMMUNE REACTIONS
  role of antitumor, of normal tissues in effectiveness of radiotherapy of human carcinomas, 25:58072
IMMUNOGLOBULINS
  radiation effects on swine serum contents of, γ, 25:58104
IN-PILE LOOPS
  design of gas-flow, for fissiochemical studies, 25:57613 (JAERI-Memo-4446)
  operation of BNL chemonuclear, experience in, 25:57610 (BNL-50293)
  power increase in indium--gallium irradiation, methods for, (E), 25:60170
INCONEL
  corrosion by molten sodium fluoride--sodium fluoroborate solution, 25:57298 (ORNL-4676, pp 73-138)
INCONEL X
  drawing of, testing of lubricants for deep, 25:58195
INCONEL 600
  compatibility with irradiated cobalt-60 fuels at 850 to 1000°C, 25:57654(R) (DP-1279)
  corrosion by sodium fluoride--sodium fluoroborate coolant salts at high temperatures, 25:58168 (ORNL-4676, pp 139-233)
  crack initiation and growth in, effects of low-cycle fatigue on, (E), 25:60061(R) (GEAP-10207-24)
  testing of fuel capsules of, at 850 to 1000°C, results of long-term, 25:57654(R) (DP-1279)
  weld defects in, morphology of, 25:58215 (Y-DA-4280)
INCONEL 625
  radiation effects on tensile properties of, alpha particle, 25:58163(R) (AI-AEC-12859)
INDIA
  nuclear power development in, role of research centers in, 25:60018
  nuclear power plant development in, status of, 25:59891
  radiation monitoring of soils of, 1964 to 1970, 25:57567
  seismology research in, review on developments in, 25:57591 (INIS-mf-71, pp 181-98)
INDIAN POINT POWER REACTOR, UNIT 1
  personnel for, exposure to airborne radioactivity of maintenance, 25:59934 (DOCKET-50003-92)
INDIAN POINT POWER REACTOR, UNIT 2
  operation of, license for, 25:59945 (DOCKET-50247-51)
  radioactive effluents from, analysis of normal and accident condition, 25:59946 (DOCKET-50247-52)
INDIAN POINT POWER REACTOR, UNIT 3
  construction of, request for not suspending permit for, 25:59965 (DOCKET-50286-39)
INDIUM
  diffusion of trace amounts of thallium in molten, thermal, 25:58267
  superconducting transition temperature of pure, determination by electrical resistance, magnetic susceptibility, and heat-capacity measurements of, 25:58949
  superconducting transitions in films of, resistivity anomalies from liquid helium contact, (E), 25:58937
INDIUM ALLOYS AND SYSTEMS
  Ag--Al--In, phase studies at 143 to 506°C, isothermal, 25:58287

- Ag-base--Cu--In, bonding to lead telluride, methods for solid-state, 25:58207
- Bi--In, density, diffusivity, and viscosity of, at 110 to 220°C, 25:58238
- Ga--In, structure of molten, quasi-eutectic, 25:58276
- Hg-base--In, diffusion in, continuous resistivity monitoring in capillary-reservoir cell for measuring, 25:58210 (IS-T-490)
- In--Sb, radiation damage in InSb, review of, 25:59138
- In-base--Pb, electron deceleration by dislocations in superconducting, (E), 25:58932
- In-base--Zn, structure of eutectic of, conditions to produce broken lamellar, 25:58286

INDIUM ISOTOPES
- determination by neutron activation and γ spectroscopy, 25:57391

INDIUM ISOTOPES In-111
- use of albumin-incorporated, for scanning cerebrospinal fluid flow kinetics in dogs, 25:58052

INDIUM ISOTOPES In-113
- distribution of metastable, during blood pool and liver scintiscanning in mice, effects of pH on, 25:58043
- evaluation of albumin aerosol-incorporated metastable, for scintigraphy of human lung ventilation, 25:58040 (UCLA-12-834)
- evaluation of metastable, for diagnostic scintigraphic studies, 25:58060

INDIUM ISOTOPES In-115
- neutron capture at 30 keV to 1.4 MeV, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801
- proton reactions (p,γ) at 4 MeV, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801

INDIUM SULFATES
- effects on nitrification by Nitrobacter agilis in soil suspension, 25:57401

INFRARED RADIATION
- absorption by irradiated germanium, relations with displaced atoms and radioinduced arsenic, gallium, and selenium in target, 25:58343
- map of galactic nucleus, (E), 25:58639

INSECTA
- Cameraria hamadryadella, radiation effects on density of, on white oak shoots, effects of dose on γ, 25:58092
- Ceratitis capitata, radioinduced inhibition of pupation of, ecdysone restoration following γ, 25:58094
- Circulifer tenellus, radiation effects on oogenesis and reproductive system of, following exposure of adults and nymphs, γ, 25:58093
- Drosophila melanogaster, radiation effects on small competing populations of, following exposure of successive generations, x, 25:57961
- Drosophila melanogaster, radiation effects on somatic crossing over in X chromosome of, effects of oxygen on x, 25:57959
- Drosophila melanogaster, radioinduced DNA synthesis in polytene chromosomes of, uv and x, 25:57951 (COO-1747-6)
- Drosophila melanogaster, radioinduced loss of chromosome X in, use of frequency of, as dosimeter, 25:57999 (NP-18944)
- Drosophila melanogaster, radioinduced mutations in, antagonistic effects of vibrations on gamma, 25:57953
- Drosophila melanogaster, radioinduced suppressor mutations in, localization of site in chromosomes of x, 25:57975
- Drosophila melanogaster, survival of larvae of, heterozygous for x-radioinduced mutations, effects of population density on, 25:57966
- Gryllus domesticus, radiation effects on neurosecretory cells in, effects of nymph head exposure dose on x, 25:58095
- Muscidifurax raptor, radiation effects on behavior of genes and chromosomes of, x, 25:57962
- weevils, radiosterilization of first and second generation, minimum dose for x, 25:58161

INSTRUMENTS
- design and operation of radiometric, review on, 25:57868
- design for simultaneous measurement of electric resistivity and radioactivity in boreholes, 25:57571(P)

INTERFEROMETERS
- use in assay of materials used in nuclear measurements, 25:59640 (CONF-711002-, pp 272-82)

INTERMETALLIC COMPOUNDS
- phase transitions in β-tungsten structure of A_3B, induced by band Jahn--Teller effect, (T), 25:58272

INTERSTELLAR MATERIAL
- composition of, (E), 25:58512
- cooling processes for, (E/T), 25:58623
- gas motions in disk of the Galaxy, (T), 25:58649
- grain alignment by galactic magnetic field, (T), 25:58647
- hydrogen interaction with solar-wind plasma and solar euv radiation, effect on interstellar magnetic-field location, (T), 25:58631
- ionization fronts in, instability of weak, (T), 25:58627
- solar-wind interaction with hydrogen in, (T), 25:58615
- spin states of atoms and molecules of, (T), 25:58665
- surface roughness of grains of, model for, (T), 25:58637
- temperature of, (E), 25:58651
- ultraviolet absorption by, (E/T), 25:58489

INTESTINES
- conference on neoplasms of human, 25:58029
- radiation effects on human, during therapy of gynecological neoplasms, effects of dose on cobalt-60 contact γ, 25:58010
- radioinduced injuries of mucosa of mouse, regeneration following gamma and x, 25:58111

INVARIANCE PRINCIPLES
- charge conjugation violation from rho^0 interference in $\omega \to \pi^+ + \pi^- + \pi^0$ decay, 25:59552
- charge conservation model for multiple hadron production in p + p interactions at high enegies, (T), 25:59512
- charge conservation model for $p + p \to 2p + m\pi^+ + m\pi^-$ interactions at high energies, (T), 25:59512
- CP conservation in $K_2^0 \to \pi^+ + \pi^- + \pi^0$ decay, spark chamber study of Dalitz plot for test of, (E), 25:59258
- CP violating amplitudes for baryon $\to$ baryon + π transitions, current algebra sum rules in Glashow model for, 25:59408
- CP violation in (K^0--anti K^0) system, second-order weak effect for parameters of, (T), 25:59540
- CP violation in $K_1^0 \to \pi^+ + \pi^- + \pi^0$ decay, spark chamber, 25:59259
- CP violation in weak interactions, quantum electrodynamics effects on, 25:59539
- CPT invariance test from ratio of total cross sections of anti p + d interactions at 6.65 GeV/c to total cross sections of anti d + p interactions at 13.3 GeV/c, (E), 25:59275
- isospin invariance in backward π + N interactions from threshold to 13 GeV/c, 25:59287
- isospin invariance in $n + d \to \pi^0 + d$ interactions from threshold to 720 MeV, (E/T), 25:59268
- parity violation in π + N interactions from longitudinal polarization of recoil nucleon, 25:59487
- scale invariance breaking in dyon model for hadrons, 25:59430
- time reversal invariance in unitarity limit of $K_2^0 \to \mu^+ + \mu^-$ decay, 25:59543

IODINE
- deposition in reactor containment buildings, heat transfer model for analysis of, 25:60111(R) (BMI-1917)
- determination as iodide using Chloramine-T, 25:57303
- determination as iodide using silver halide electrode, potentiometric, 25:57314
- determination in drugs by radioisotope x-ray fluorescence, use of Ross filters in, 25:57322
- determination using graphite--platinum electrode system, biamperometric, 25:57302
- positron annihilation at 80 to 180 keV, cross sections and spectra from single-quantum, (E), 25:58723
- removal by sodium thiosulfate in ice cubes of ice condenser reactor containment systems, (E), 25:60124
- separation of iodide, iodate, and periodate forms of, by paper, ion-exchange, and thin-layer chromatography and electrophoresis, 25:57559

IODINE IONS
- reactions of beams of, with solid butane at 3000 to 50 eV, 25:57459
- reactions with molecules at 12 MeV, electron-capture and -loss cross sections for, (E), 25:58768
- reactions with nitric oxide and oxygen molecules, effects of thermal motion of molecules on charge exchange in, (T), 25:58752

IODINE ISOTOPES I-125
- incorporation in difluoresceinylmercury compounds for use in diagnosis of ischemically injured tissues, 25:58047(P)

IODINE ISOTOPES I-127
- neutron capture at 400 keV, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801
- photon reactions (γ,n) with, energy dependence of yield for, (E), 25:59815

IODINE ISOTOPES I-131
- content in off-site milk following Schooner Event, (E), 25:57574 (PNE-524)
- content of cows' milk following ingestion of hay contaminated with Plowshare debris, 25:57948 (SWRHL-85-r)
- determination in biological materials by isotopic exchange and scintillation counting, 25:57367
- determination in reactor effluent water by ion exchange and γ spectroscopy or radiochemical methods, 25:57351
- diagnostic value for serial scintigraphy of human thyroid gland, 25:58056
- effectiveness for post-surgical interstitial therapy of human thyroid adenomas, 25:58056
- effectiveness of rose bengal-incorporated, for scanning liver for diagnosis of adenomas, 25:58046
- effectiveness of triiodothyronine-incorporated, for scintiscanning of human liver in comparison to colloidal gold-198 and iodine-131-labeled thyroxine, 25:58050
- effects on operant behavior and thyroid gland of rats following intraperitoneal injection during gestation, 25:58100
- exchange between alkali metal iodides and substituted aryl iodides, effects of electrolytic dissociation on,

XUM

  25:57425
  excretion and retention time in man following acute or chronic intake, method for calculation of, 25:57919
  incorporation in difluoresceinylmercury compounds for use in diagnosis of ischemically injured tissues, 25:58047(P)
  preparation of carrier-free, 25:57559
  radiation effects on clearance rate in skin of man and rabbits, x, 25:58125
  release in TRU processing of HFIR targets, 25:57524 (ORNL-TM-3343)
  use for interstitial therapy of thyroid carcinomas and hyperthyroidism in man, possibility of contamination of environment through, 25:58079
  use in thyroid functional activity studies of gerbils, 25:57915
  use of bromsulphalein-incorporated, for scanning human liver function, 25:58042
IODINE ISOTOPES I-132
  excretion and retention time in man following acute or chronic intake, method for calculation of, 25:57919
IODINE ISOTOPES I-135
  monitoring in liquid sodium, development of method for, 25:60058(R) (ANL-7817)
ION-ACOUSTIC WAVES
  interactions with ionization waves in discharges, (E/T), 25:59098
ION BEAMS
  energy-level abundances in, method for measurement of excited, 25:58763
  production by laser irradiation of thin foils, 0.1-GeV, 25:59341
  use in preparation of thin graphite foils for electron microscopy, 25:58350 (RD/B/N-2020)
ION EXCHANGE MATERIALS
  development of EDE-10P type, based on fluoropolymers, 25:57555
  efficiency of macroreticular, in TBP solvent cleanup in Purex Process, 25:57509 (ARH-SA-58)
ION SOURCES
  performance of high-current hollow-cathode, for Hall accelerators, 25:59080
  space charge neutralization at, electron beam, (T), 25:58688
IONIZATION
  theory of auto-, many-body, 25:58802
IONOSPHERE
  book: Studies of Atmosphere and Ionosphere at Times of Unusual Solar Activity, (E), 25:58893
  D region, investigation during sunrise of, model of, (E/T), 25:58899
  E region, electron drift in equatorial electrojet, effect of magnetic activity on, (E/T), 25:58905
  E region, winds induced by auroral electrojet heating in, (T), 25:58864
  electric coupling with magnetosphere, relation to polar magnetic disturbances and auroral break-up, (E/T), 25:58909
  electrojet-current intensity in auroral forms in, relation to visual aurorae occurrence, (E), 25:58857
  electron content enhancements in, relation to simultaneous sudden frequency deviations during solar-flare events, (E), 25:58901
  electron-density irregularities in, relation to electrostatic plasma instabilities in equatorial electrojets, (E/T), 25:58900
  F region, electron drift in equatorial electrojet, effect of magnetic activity on, (E/T), 25:58905
  F region, ion density in nighttime, morphology of 6300-A airglow associated with molecular, (E/T), 25:58884
  F2 layer, height variations in peak, semiannual, (E/T), 25:58879
  F2 layer, interaction with internal acoustic-gravity waves, (E/T), 25:58872
  F2 layer, irregularities in, Hall drift and daytime west-east electric-field explanation of upward-moving, (E/T), 25:58877
  ion diffusion in weakly ionized homogeneous, test ambipolar, (E/T), 25:58862
  irregularities in subequatorial, upward-moving, (E/T), 25:58877
  magnetic-storm effects in, (T), 25:58865
  particle event over polar cap in March 1970, observation of solar, (E), 25:58892
  plasma instabilities in, review of, 25:58895
  proton density in midlatitude, associated with magnetic storms, dynamics of thermal, (E), 25:58867
  pulsation time lag of cosmic-noise absorption in auroral, behind simultaneous x-ray pulsations, luminosity, and micropulsations, (E/T), 25:58863
  radio-wave absorption in, phase-integral calculation of reflected, (T), 25:58875
  radio-wave absorption in, regular and irregular winter anomaly in midlatitude, (E/T), 25:58880
  radio-wave propagation in, magneto-ionic mode coupling of hf, (T), 25:58871
  radio-wave propagation in, magneto-ionic mode coupling of hf, (T), 25:58870
  radio-wave propagation under daytime, geomagnetic-field effect on 1 to 4 kHz elf and vlf, (T), 25:58873
  radio-wave reflection and transmission in, effect of geomagnetic field on, (T), 25:58869
  radio-wave reflection and transmission in, variation of penetrating and non-penetrating modes in, thin-film optical method for height and frequency, (T), 25:58878
  sporadic E, thickness from phase advance on echoes from F region, (E), 25:58881
IONS
  channeling and blocking in crystals, review of, 25:59151
  channeling in crystals, review, 25:59165
  channeling in crystals, review of principles and applications of, 25:59167
  diffusion in weakly ionized plasma, test ambipolar, (E/T), 25:58862
  effects on incidence of single- and double-strand breaks in phi X-174 replicative form of DNA, effects of LET on, 25:57952 (LBL-28)
  effects on semiconductors, review of, 25:59173
  effects on silicon and germanium, crystallinity and damaged regions in, (E/T), 25:59140
  effects on void formation at high temperatures, use to simulate fast neutron, 25:58320
  electron reactions with closed-shell, construction of model potentials for, 25:58772
  energy loss distribution in single crystals of heavy positive, effects of channeling on, (T), 25:59150
  energy losses at low energies in solids, calculation using screened Coulomb potential, 25:59124
  energy of free, containing one or two open shells, computer program for, 25:58709
  energy of many-electron, formula for relativistic, 25:58819
  energy-level transitions of one- and two-electron, magnetic-dipole operator for calculation of, 25:58803
  implantation in binary III--V semiconductors, review, 25:59168
  implantation in solids, channeling-effect technique for study of, 25:59167
  implantation in solids, review of range distributions in, 25:59166
  interactions in system of, many body theory for composite, 25:59232
  ionization potentials of, containing one to ten electrons, review of, 25:58715
  physics of gaseous, Yugoslav summer school in July 1970 on, 25:58739
  properties of two-electron, solution of delta-function model for, 25:58805
  reactions with atoms in keV range, effects of velocity and outer-shell configuration on production of K vacancies in, (E), 25:58756
  reactions with atoms, energy spectra of electrons from, (T), 25:58733
  reactions with atoms, merging-beams method for study of, 25:58744
  reactions with atoms, review of charge exchange in, (E), 25:58743
  reactions with gaseous and metal-vapor targets, review of excited-atom formation by charge exchange in, 25:58691
  reactions with molecules, additive rule for charge-exchange cross sections for, 25:58768
  reactions with molecules, Doppler broadening due to thermal motion of molecules in beam experiments on, (T), 25:58752
  reactions with P-state atoms, depolarization in, (T), 25:58746
  reactions with solid surfaces, review of Auger and resonance processes in, (E/T), 25:58692
  reactions with solids, review of angular and energy distributions and yields from sputtering in, 25:58693
IRIDIUM ALLOYS AND SYSTEMS
  Cm--Ir, preparation of intermetallic $CmIr_3$, by oxide reduction reactions, 25:57658(R) (ORNL-4723)
IRIDIUM ISOTOPES
  determination by neutron activation and γ spectroscopy, 25:57391
IRIDIUM ISOTOPES Ir-191
  energy levels from Coulomb excitation and platinum-191 electron-capture decay, spin--parity assignments for, (E), 25:59805
  energy-level transitions from Coulomb excitation and platinum-191 electron-capture decay, branching and mixing ratios, conversion coefficients, multipolarities, and probabilities for, (E), 25:59805
  nuclear g-factor for isomeric, NMR measurement of, (E), 25:59807
  oxygen-16 inelastic scattering at 25 to 65 MeV with Coulomb excitation, gamma spectra from, (T), 25:59805
IRIDIUM ISOTOPES Ir-192
  nuclear g-factor for, NMR measurement of, (E), 25:59807
IRON
  abundance in Am stars, (E/T), 25:58438
  bonding to lead telluride, methods for solid-state, 25:58207
  content of particulate, in operational high-temperature sodium loops, 25:58170 (RD/B/N-1998)
  determination by extraction using quinolinol melt and spectrography, 25:57312
  determination by potentiometric titration using potassium chlorate, 25:57309
  determination in fuel solutions of JRR-1, 25:57320
  determination in sodium, spark mass spectrometric, 25:58163(R) (AI-AEC-12859)

- determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
- determination of trace amounts of, in tungsten trioxide or zirconium dioxide, effects of halide additives on direct spectrographic, 25:57335
- effects on chemical states of radioisotopes in seawater, 25:57410
- effects on mechanical properties of molybdenum single crystals, 25:58257
- etching by selective cavitation, method for, 25:58190
- mechanical properties of, effects of fatigue on, 25:58223
- microstructure of, effects of fatigue on, 25:58223
- neutrino reactions with, angular and momentum distributions of μ^+ and e^+ in direct production of lepton pairs in, (T), 25:59415
- neutrino reactions with, μ^- angular and momentum distributions for μ^- and W^+ production in, (T), 25:59414
- production of, lanthanum-140 tracer method for measuring agglomerate mixing efficiency of sintering facility for, 25:57659
- production of, use of process heat reactors for, 25:60200
- proton reactions at 400 GeV, Monte Carlo calculations of nucleon- and meson (π)-induced star and flux distributions from, (T), 25:59507 (ORNL-4673)
- radiation effects on catalytic activity of, in ammonia synthesis, 25:57444
- radiation effects on solubility in sodium at high temperatures, in-pile, 25:58163(R) (AI-AEC-12859)
- radioinduced helium production in, measurement of in-pile, 25:58163(R) (AI-AEC-12859)
- reactions of trivalent, with silicic acid in aqueous solutions, spectrophotometric study of, 25:57406
- separation from plutonium by solvent-extraction using TBP, 25:57357
- solvent properties of austenitic, for niobium nitride, effects of chromium, manganese, nickel, and silicon on, 25:58268
- spectra of, collision broadening effects of neutral hydrogen on, (T), 25:58509
- spectral lines of, wavelengths of 68 solar, (E), 25:58595

IRON ALLOYS AND SYSTEMS
- analysis for niobium using magneson, photometric, 25:57315
- coating with molybdenum and tungsten for corrosion protection, chemical vapor deposition method for, 25:58168 (ORNL-4676, pp 139-233)
- Al--Co--Cu--Fe-base--Ni, properties and structure of, effects of neodymium additions on, 25:58250
- C--Cr--Fe--Hf--Mn--Mo--Nb--Ni-base--Si--Ti--Zr, radiation effects on mechanical properties of, relations of composition with thermal neutron, 25:58168 (ORNL-4676, pp 139-233)
- C--Cr--Fe--Ni--Si--W, metallography of carbide structures in cast heat-resistant, 25:58399
- Co--Fe-base--Mo, hardness of dispersion-hardening hard facing, effects of primary and secondary additions on, 25:58235
- Co--Fe-base--Mo--Ni, aging of, dilatometric, electric conductivity, and electron microscopy studies on, 25:58232
- Co--Fe-base--W, hardness of dispersion-hardening hard facing, effects of primary and secondary additions on, 25:58235
- Co-base--Fe--Mo--Ti, magnetic properties of wires of, 25:59197
- Fe--Ni--V, electric, magnetic, and mechanical properties of $Ni_3(Fe,V)$ solid solutions, 25:59188
- Fe--V, analysis for vanadium following ion exchange chromatographic separation, potentiometric, 25:57339
- Fe--Zr-base, properties of dilute cast, electric and mechanical, 25:58258
- Fe-base--Mo--Ni, aging of, dilatometric, electric conductivity, and electron microscopy studies on, 25:58232

IRON ISOTOPES Fe-52
- energy levels of, calculation for α-hole, 25:59757
- production in cyclotrons, evaluation of methods for recovery from targets in, 25:57486
- production in stars from simple helium burning, (E), 25:58508

IRON ISOTOPES Fe-56
- energy levels from (γ,n) reactions at threshold, review of doorway, (E), 25:59784 (UCRL-73336)
- neutrino scattering by, weak nucleon processes for impulse approximation for quasielastic forward, (T), 25:59397
- photon reactions (γ,n) at threshold, review of cross sections and photon doorways for, (E), 25:59784 (UCRL-73336)
- proton reactions at 1 TeV, effect of intermediate resonance production on cross sections for elastic and inelastic, 25:59519

IRON ISOTOPES Fe-57
- energy levels from (γ,n) reactions at threshold, review of doorway, (E), 25:59784 (UCRL-73336)
- photon reactions (γ,n) at threshold, review of cross sections and photon doorways for, (E), 25:59784 (UCRL-73336)

IRON ISOTOPES Fe-59
- determination in water by polarography or scintillation γ spectrometry, 25:57346 (IFA-FR-82)
- radiation effects on incorporation in lymphoid cells of mice, effects of antiserum on x, 25:58120
- radiation effects on relation between total uptake and uptake by heme and nonheme fractions of bone marrow and spleen of mice, x, 25:58119

IRON ORES
- analysis for vanadium following ion exchange chromatographic separation, potentiometric, 25:57339

IRON OXIDES Fe_2O_3
- effects on thermostability of irradiated polyethylene, 25:57446

IRON SULFATES
- $CuSO_4$--$FeSO_4$--$Fe_2(SO_4)_3$--$ZnSO_4$, complex ion distribution in aqueous solutions of, 25:57398 (NIM-1093)
- $Fe_2(SO_4)_3$--UO_2SO_4, complex ion distribution in aqueous solutions of, 25:57398 (NIM-1093)

IRRADIATION FACILITIES
- design of improved, incorporating oxygen removal method, 25:57625(P)
- design of low-temperature, for studies of heavy-ion bombardment effects on metal foils, 25:57620 (RISO-204)
- design of spiral-flow gamma, for sterilizing liquids and sewage, 25:57636(P)
- operation of gamma, for irradiating wood, computer control system for, 25:57628
- radiation conditions in cobalt-60, measurements of, 25:57631

ISOTOPE EFFECTS
- calculations of relative deuterium--tritium, in absence of large tunneling factors, 25:57430
- use in ordering of carbon--hydrogen bond strengths, 25:57426

ISOTOPE SEPARATION METHODS
- development in Federal Republic of Germany, 25:57666
- separation cascades for, theory for optimum multicomponent nonsymmetric, 25:57670

ISOTOPES
- book: Isotopes: Bibliographies and Reference Tables. Volume III, 25:59697
- determination by recoilless resonance absorption or scattering of γ rays, 25:57354(P)

J

JAMES A. FITZPATRICK POWER REACTOR
- construction of, request for not suspending permit for, 25:59981 (DOCKET-50333-32)
- cooling system for, test and inspection of main steam isolation valve discs and recirculation bypass valves of, 25:59980 (DOCKET-50333-31)
- pressure vessel nozzle for, quality assurance program evaluation of damage to, 25:59980 (DOCKET-50333-31)

JAPAN
- geologic deposits at base of Mt. Obora, measurement of radioactivity in, 25:57566
- nuclear power plant construction in, civil engineering aspects of, 25:59895
- nuclear power plant development in, projections of, 25:59906
- nuclear power plants in, economic and safety aspects of, 25:59905
- nuclear power plants in, effects of uranium enrichment technology on development of, 25:59904
- nuclear power plants in, petroleum industry competition for development of, 25:59903
- power reactors in, fuel cycle economics for, 25:59928
- radiation effects on blood cell counts in medical personnel in, during 1969, survey of, 25:58134
- radiation processing of food in, status of research on, 25:58159
- radioisotope contents in atmosphere of, during 1963 to 1971, measurements of cesium-137 and strontium-90, 25:57579

JAPANESE ADVANCED THERMAL REACTOR
- design parameters for, 25:59902
- safety aspects of, 25:59902

JAPANESE EXPERIMENTAL FAST REACTOR
- buildings for, construction schedule for, 25:60190
- buildings for, design parameter and stress loading requirements for, 25:60189
- containment structure for, construction schedule for, 25:60190
- containment structure for, design parameters and stress loading requirements for, 25:60188
- cooling system for, design parameters of double loop liquid sodium, 25:60175
- core for, design parameters of, 25:60176
- design parameters of, 25:60177
- fuel elements for, design parameters of, 25:60176
- loading machine for, 25:60174
- remote handling equipment for, 25:60174
- site for, excavation and preparation of, 25:60190

JOSEPH M. FARLEY POWER REACTOR, UNIT 1
- site for, use of runway for aircraft operation on, 25:59988 (DOCKET-50348-27)

XUM

JOSEPH M. FARLEY POWER REACTOR, UNIT 2
  site for, use of runway for aircraft operation on, 25:59988 (DOCKET-50348-27)
JUPITER (PLANET)
  asteroid capture by, Deser--Laurent theory of gravitation for mechanism for, (T), 25:59585
  interior of, phase diagrams of hydrogen and helium in, (E), 25:58675

K

KALPAKKAM POWER REACTORS
  construction of, unique engineering features of, 25:59892
KAOLINS
  effects on thermostability of irradiated polyethylene, 25:57446
KASHIMA POWER REACTOR, UNIT 1
  emergency core cooling system for, performance of, 25:59897
KEWAUNEE POWER REACTOR
  construction of, request for not suspending permit for, 25:59970 (DOCKET-50305-26)
KIDNEYS
  californium-252 distribution in rat, following intraperitoneal injection, 25:57922
  radiation effects on adenine nucleotides in rat, x, 25:57936
KRYPTON
  determination of radioactive, released from fuel elements by gas chromatography and γ spectrometry, continuous, 25:57344 (CEA-R-4218)
  oxygen-ion (O$^+$) reactions at 10 to 170 eV with, effects of excited states on charge exchange in, (E), 25:58763
  radioinduced reactions with fluorine, electron or proton, 25:57455
  solubility in sodium, 25:58387(R) (ANL-7823)
KRYPTON FLUORIDES
  radioinduced production from fluorine and krypton, electron or proton, 25:57455
KRYPTON IONS
  effects on benzene vapor at 60 keV, yields from, 25:57469
  effects on germanium monocrystals at 10 to 30 keV, electron emission induced by, 25:59175
  reactions with germanium crystals at 10 to 30 keV, angular dependence of, (E/T), 25:59146
KRYPTON ISOTOPES Kr-85
  separation from other krypton isotopes by ion implantation in aluminum, 25:57650 (CONF-711002-, pp 10-20)

L

LA CROSSE BOILING-WATER REACTOR
  cooling system for, corrosion of A335 P11 steel in, 25:59932 (DOCKET-1155-137)
  instrumentation of, power testing of automatic gain control system for, 25:59931 (DOCKET-1155-136)
  personnel for, use and protection factors for respiratory protective equipment for, 25:59933 (DOCKET-1155-138)
LA SALLE COUNTY POWER REACTOR, UNIT 1
  design parameters of, revised and additional data on, 25:59995 (DOCKET-50373-10)
  operations aspects of, revised and additional data on, 25:59995 (DOCKET-50373-10)
LA SALLE COUNTY POWER REACTOR, UNIT 2
  design parameters of, revised and additional data on, 25:59995 (DOCKET-50373-10)
  operations aspects of, revised and additional data on, 25:59995 (DOCKET-50373-10)
LABORATORIES
  description of CNEN plutonium, 25:58351 (RT/ING-(70)30)
LABORATORY EQUIPMENT
  design for measuring thermodynamic properties of liquid metals, engineering drawings for, 25:57635
  shipping of Mark II Test Assembly, vibration testing of equipment for, 25:57612 (HEDL-TME-71-114)
LACQUERS
  book: Radiation Stability of Lacquer Coatings, 25:58420
LACTATE DEHYDROGENASE
  radiation effects on activity in serum and vaginal tissues of cervical cancer patients, effects of dose on γ, 25:57937
LANTHANUM
  abundance on surfaces of peculiar A stars, (E/T), 25:58462
  complexes with HEDTA, dissociation constants for, 25:57537
  determination in pyrolytic graphite by neutron activation and counting of delayed β and γ coincidences, 25:57389
  determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
  preparation of targets of, by vacuum evaporation, 25:59638 (CONF-711002-, pp 116-21)
  separation from fission products by electromigration following complexing with nitrilotriacetic acid, 25:57558
  separation from transuranium elements by electromigration, 25:57520 (JINR-E6-5952)
LANTHANUM BORIDES
  electric properties of LaB$_6$, effects of hafnium, rhenium, tantalum, and tungsten additions on, 25:59182
  electric properties of LaB$_6$, temperature dependence of effects of hafnium, rhenium, tantalum, and tungsten additions on, 25:59183
LANTHANUM IONS
  energy levels of La III, (E), 25:58707
LANTHANUM ISOTOPES La-135
  energy levels of, determination of electromagnetic transition probabilities from mean lifetimes of, (E), 25:59776 (FRNC-TH-56)
LANTHANUM ISOTOPES La-139
  neutron reactions (n,α) at 14.2 MeV, presence of direct effects in spectra from, (E/T), 25:59802
  photon reactions at 250 MeV, analysis using residual nucleus method, (E), 25:59815
LANTHANUM ISOTOPES La-140
  determination in reactor effluent water by ion exchange and γ spectroscopy or radiochemical methods, 25:57351
  production from barium-140, colloid-filtration method for, 25:57352
  use as tracer for measuring mixing efficiency of sintering facility for producing iron agglomerate, 25:57659
LANTHANUM OXIDES
  effects on structure of γ-irradiated sodium oxide--tellurium oxide glasses, EPR spectral studies on, 25:57447
  CaO--La$_2$O$_3$, electric properties of solid electrolytes, 25:59193
LANTHANUM PHOSPHATES
  luminescence of cerium and terbium ions in, effects of thorium ions on, 25:59185
LANTHANUM SELENIDES
  dissociation energy of, 25:57435(R) (COO-1029-39)
LARVAE
  survival of Drosophila, heterozygous for x-radioinduced mutations, effects of population density on, 25:57966
LASER RADIATION
  reactions with thin foils, 0.1-GeV ions from, 25:59341
LASERS
  performance for heating deuterium--tritium plasmas, (T), 25:58965
  pulsing of, spark gaps for, 25:59076(T) (UCRL-Trans-10556)
  use for controlled thermonuclear research, 25:59054 (MATT-782)
  use for electron density and temperature measurements in argon plasma jets, (E/T), 25:58987
  use for plasma heating, prospects for, 25:59057
  use in controlled thermonuclear research, review of, 25:59058
LAWRENCIUM
  oxidation potential for trivalent--tetravalent, 25:57437
LEAD
  abundance on surfaces of peculiar A stars, (E/T), 25:58462
  alpha inelastic scattering at 15 MeV with Coulomb excitation of natural, gamma spectra from, (E), 25:59804
  determination by extraction using quinolinol melt and spectrography, 25:57312
  determination in pure rare earth oxides, polarographic, 25:57311
  deuteron reactions at 0.85 to 1.7 GeV/c, neutron yield from, (E), 25:59820
  diffusion of trace amounts of thallium in molten, thermal, 25:58267
  fabrication of targets of, for heavy-ion energy loss measurements, 25:59639 (CONF-711002-, pp 134-43)
  photon reactions at 560 MeV, emulsion study of dependence on atomic weight for yields of π^+ and π^- from, (E), 25:59248
  photon reactions with, secondary electron emission from, (E/T), 25:59107
  preparation of thin-film targets of, using Zapon temporary backing, 25:59639 (CONF-711002-, pp 134-43)
  proton reactions of 0.85 to 1.7 GeV/c, neutron yield from, (E), 25:59820
  separation from plutonium by solvent extraction using TBP, 25:57357
  superconducting transition temperature of deformed lattice of, anomalous behavior of, 25:58933
LEAD ALLOYS AND SYSTEMS
  In-base--Pb, electron deceleration by dislocations in superconducting, (E), 25:58932
LEAD CHLORIDES
  KCl--PbCl$_2$, spectra at 400°C, Raman, 25:58387(R) (ANL-7823)
  KCl--PbCl$_2$, spectra at 590°C, Raman, 25:58387(R) (ANL-7823)
LEAD IONS
  effects on benzene vapor at 60 keV, yields from, 25:57469
LEAD ISOTOPES
  neutron pairing in, equilibrium, (T), 25:59833 (JINR-E4-5907)
LEAD ISOTOPES Pb-204
  energy-level transitions from Coulomb excitation,

  - probabilities for, (E), 25:59804
  - neutron reactions (n,2n) at 14.8 MeV, cross sections and gamma spectra from, (E), 25:59797
- LEAD ISOTOPES Pb-206
  - energy level at 2645.3 keV from Coulomb excitation, lifetime for, (E), 25:59804
  - energy levels at 3957.6 and 4027.2 keV from mercury-204 $(\alpha,2n)$ reactions, E2 transition probabilities for, (E), 25:59818
  - energy-level transitions from Coulomb excitation, probabilities for, (E), 25:59804
- LEAD ISOTOPES Pb-207
  - alpha inelastic scattering at 18 MeV with Coulomb excitation, gamma spectra from, (E), 25:59804
  - energy levels from (γ,n) reactions at threshold, review of doorway, (E), 25:59784 (UCRL-73336)
  - energy levels from Coulomb excitation, lifetimes for, (E), 25:59804
  - energy-level transitions from Coulomb excitation, probabilities for, (E), 25:59804
  - oxygen-16 inelastic scattering at 70 MeV with Coulomb excitation, gamma spectra from, (E), 25:59804
  - photon reactions (γ,n) at threshold, review of cross sections and photon doorways for, (E), 25:59784 (UCRL-73336)
- LEAD ISOTOPES Pb-208
  - deuteron elastic scattering at 80 MeV, optical-model analysis of angular distributions from, (E), 25:59754
  - energy levels from (γ,n) reactions at threshold, review of doorway, (E), 25:59784 (UCRL-73336)
  - energy levels of, spins and parities of, (E), 25:59778 (JAERI-Memo-4520)
  - energy-level transitions from Coulomb excitation, probabilities for, (E), 25:59804
  - isovector potential strength in, estimation from partial muon capture, (T), 25:59808
  - photon reactions (γ,n) at several hundred keV, cross section for, (E), 25:59778 (JAERI-Memo-4520)
  - photon reactions (γ,n) at threshold, review of cross sections and photon doorways for, (E), 25:59784 (UCRL-73336)
- LEAD ISOTOPES Pb-214
  - determination in presence of bismuth-214 and radium-226 by gamma spectrometry, 25:57365
- LEAD TELLURIDES
  - bonding to alloys and metals, methods for solid-state, 25:58207
- LEAK DETECTORS
  - design and operation of photographic, for monitoring sealed radium sources, 25:57707
  - design and performance of, for sodium-heated steam generators, 25:57632
  - design of electric, 25:60286 (SC-DR-710418)
- LEPTONS
  - decay of heavy, angular correlations of charged particles from, (T), 25:59390
  - interactions of polarized, photon radiation during weak, (T), 25:59402
  - interactions of, two- and four-component neutrino theories from leptonic and semileptonic, (T), 25:59407
  - interactions with hadrons, inclusive parton model for semi-inclusive, 25:59401
  - interactions with nucleons, relativistic model for inelastic form factors, widths, and locations of N* production in, (T), 25:59337
  - production of heavy, in $e^+ + e^-$ colliding-beam interactions, cross section for, (T), 25:59390
  - production of heavy, in hadron interactions with hadrons in parton model, 25:59401
  - production of l^+--l^- pairs in neutrino reactions with iron, angular and momentum distributions of μ^+ and e^+ in direct, (T), 25:59415
  - production of l^+--l^- pairs in neutrino reactions with nuclei, angular and momentum distributions of μ^+ and e^+ in direct, (T), 25:59415
- LEUKOCYTES
  - radiation effects on count of, in medical personnel in Japan during 1969, survey of, 25:58134
  - radiation effects on cultured human umbilical cord, comparison of effects of chemical carcinogens, viruses, and x, 25:57921
- LIGHT
  - bending near sun, effects of torsion on, (T), 25:59605
  - effects on electrophysiological activity of nerve fibers, molecular basis of, 25:57942
- LIGHT COMMUNICATION SYSTEMS
  - design for power modulator for linac, 25:59660(P)
- LIGHT SOURCES
  - oxide coatings on lamp cathode, radioisotope tracer studies of losses from barium--calcium, 25:57660
- LIGHTNING
  - radiation from electrical discharges during complete flash of, pulse characteristics of, (E), 25:58876
- LIMERICK POWER REACTOR, UNIT 1
  - cooling system for, additional data on secondary, 25:59990 (DOCKET-50352-22)
  - design parameters for, revised and additional data on, 25:59990 (DOCKET-50352-22)
  - emergency core cooling system for, performance evaluation for, 25:59990 (DOCKET-50352-22)
  - operation of, effects on ecosystems of, 25:59989 (DOCKET-50352-21)
  - radioactive effluents from, calculations for annual, 25:59990 (DOCKET-50352-22)
- LIMERICK POWER REACTOR, UNIT 2
  - cooling system for, additional data on secondary, 25:59990 (DOCKET-50352-22)
  - design parameters for, revised and additional data on, 25:59990 (DOCKET-50352-22)
  - emergency core cooling system for, performance evaluation for, 25:59990 (DOCKET-50352-22)
  - operation of, effects on ecosystems of, 25:59989 (DOCKET-50352-21)
  - radioactive effluents from, calculations for annual, 25:59990 (DOCKET-50352-22)
- LINEAR ACCELERATORS
  - beam injector for electron, 25:59659(P)
  - description of ML-15M II 15-MeV electron, for therapy, 25:59661
  - experimental facilities at Kharkov 300-MeV electron, description of, 25:59646
  - performance of prototype electron, in nondestructive analysis of nuclear materials, 25:57704 (GULF-RT-A-10826)
  - power modulator for, infrared light data link for controlling, 25:59660(P)
- LINEAR ENERGY TRANSFER
  - effects on incidence of radioinduced single- and double-strand breaks in phi X-174 replicative form of DNA, 25:57952 (LBL-28)
  - relation to radiation quality factor, 25:58005
- LIQUID METAL FAST BREEDER REACTOR
  - accidents in, review of U.S. safety programs on, 25:60132
  - breeding distribution in, activation method for measurement of, 25:60050
  - coolant boiling in sodium cooled, development of detection methods for, 25:60089
  - coolant boiling in, development of high temperature acoustic sensors for detection of, 25:60090
  - coolant for, benchmark measurements on shielding effects of sodium, 25:60055(R) (ORNL-TM-3573)
  - coolant for, monitoring and sampling system for liquid sodium, 25:60005(R) (ANL-7854)
  - core meltdown accidents in, methods for analysis of mechanical work energy produced during, (T), 25:60121
  - development during August 1971, 25:60005(R) (ANL-7854)
  - fission product yields in, measurement of, (E), 25:60035(R) (ANL-7824)
  - fuel cycle development for, 25:57507(R) (ANL-7799)
  - fuel element cladding for, testing of stainless steel, 25:58163(R) (AI-AEC-12859)
  - fuel element failures in, development of methods for detection of, 25:60058(R) (ANL-7817)
  - fuel elements for, performance of, 25:60005(R) (ANL-7854)
  - fuel rod bundles in, ORRIBLE code for flow and temperature distribution in, 25:60062 (ORNL-TM-3516)
  - fuels for, development and radiation testing of, 25:58344(R) (LA-4693)
  - fuels for, development of methods for chemical analysis for, 25:58344(R) (LA-4693)
  - fuels for, reprocessing methods for, 25:60005(R) (ANL-7854)
  - instrumentation for, development of, 25:60005(R) (ANL-7854)
  - physics parameters of, calculation of, (T), 25:60042
  - power distribution in, activation method for measurement of, 25:60050
  - safety aspects for, heat transfer and fluid flow analysis for, 25:60005(R) (ANL-7854)
  - safety aspects of, review of U.S. programs on, 25:60132
  - shutdown margin measurements for, two frequency reactor noise method for, (T), 25:60043
  - steam generators for, design of hydrogen meter for leak detection in, 25:60058(R) (ANL-7817)
  - transfer function measurements for, analysis of space dependent effects in, (T), 25:60041
- LIQUIDS
  - radiosterilization of, design of spiral-flow gamma facility for, 25:57636(P)
  - vapor bubble nucleation in superheated, research on, 25:58387(R) (ANL-7823)
- LITHIUM
  - effects on complexonometric determination of rare earths, 25:57317
  - preparation of standard thin-film layers of, by vacuum evaporation, 25:58182 (CONF-711002-, pp 122-33)
  - proton stopping power at 20 to 1000 keV of, electronic, (T), 25:59124
  - purification of heat-pipe, methods for, 25:57615(R) (LA-4746)
  - reactions with hydrogen, plans for studies on, 25:58387(R) (ANL-7823)
- LITHIUM ALLOYS AND SYSTEMS
  - Bi--Li, solvent properties for neodymium and thorium, 25:57522 (ORNL-4676, pp 234-71)
  - Li--LiBr--RbBr--Se, thermodynamic properties of, emf measurements of, 25:58387(R) (ANL-7823)
  - Li--S, phase studies of, 25:58387(R) (ANL-7823)
  - Li--Te, phase studies of, 25:58387(R) (ANL-7823)
- LITHIUM BERYLLIUM FLUORIDES
  - reactions of molybdenum or niobium fluorides in molten,

  kinetics of, 25:57298 (ORNL-4676, pp 73-138)
  solvent properties of molten, for helium and hydrogen, 25:57298 (ORNL-4676, pp 73-138)
LITHIUM BROMIDES
  Li--LiBr--RbBr--Se, thermodynamic properties of, emf measurements of, 25:58387(R) (ANL-7823)
LITHIUM CHLORIDES
  copper (II) in ESR spectra in, 25:59201
  KCl--LiCl, plutonium oxidation in molten, chronopotentiometric study of, 25:57420
LITHIUM FLUORIDES
  elastic precursor decay in single crystals of, effects of point defects on, 25:59126
  helium-atom scattering by (001) surface of, (E), 25:58694
  radiation effects on elastic precursor decay in single crystals of, gamma, 25:59126
  BeF$_2$--LiF, solvent properties of molten, for gaseous boron trifluoride, 25:57298 (ORNL-4676, pp 73-138)
  BeF$_2$--LiF, thermodynamic properties of molten, 25:57298 (ORNL-4676, pp 73-138)
  BeF$_2$--LiF--ThF$_4$, separation of cesium and rubidium from, by reductive extraction, 25:57298 (ORNL-4676, pp 73-138)
  BeF$_2$--LiF--ThF$_4$--UF$_4$, heat transfer and thermophysical properties of, (E/T), 25:60015 (ORNL-4676, pp 21-72)
LITHIUM IONS
  electron reactions with, model potentials for, 25:58772
  implantation in silicon for use as charged-particle detectors, 25:57749
  reactions with hydrogen molecules at 10 to 110 keV, polarization of Hβ line produced by dissociation and excitation in, (E), 25:58780
  wave functions for excited two-electron, Hulthen transform functions in approximation of, 25:58713
LITHIUM ISOTOPES
  abundance in primary cosmic radiation, (E), 25:58833
LITHIUM ISOTOPES Li-6
  deuteron reactions (d,α) at 400 to 960 keV using polarized beam, analyzing power for, (E), 25:59737
  lithium-6 reactions (Li-6,2α) at 6.0 MeV, angle--energy contours and energy spectra from, (E), 25:59718
  meson reactions $(\pi^+,2p)$ at 70 MeV, excitation spectra for, (E), 25:59709 (LA-DC-12389)
  proton inelastic scattering by, approximate G-matrix calculations for, (T), 25:59858
  reactions (Li-6,2α) with lithium-6 at 6.0 MeV, angle--energy contours and energy spectra from, (E), 25:59718
LITHIUM ISOTOPES Li-7
  helium-3 reactions (He-3,d) and (He-3,t) at 15 MeV, deuteron and triton spectra from, (E), 25:59731
  lithium-7 reactions (Li-7,2p) at 30 MeV, cross sections and Q-value spectra from, (E), 25:59716
  reactions (Li-7,2p) with carbon-12 and lithium-7 at 30 MeV, cross sections and Q-value spectra from, (E), 25:59716
LITHIUM ISOTOPES Li-8
  production in proton reactions with nuclear emulsions at 28 GeV, energy spectra of, (E), 25:59278
LITHIUM MOLYBDENUM FLUORIDES
  crystal structure, 25:57298 (ORNL-4676, pp 73-138)
LIVER
  californium-252 distribution in rat, following intraperitoneal injection, 25:57922
  function of human, use of iodine-131-labeled BSP and gamma camera in tests of, 25:58042
  radiation effects on adenine nucleotides in rat, x, 25:57936
  radiation effects on cells of rat, mechanism for x, 25:58130
  radiation effects on ultrastructure of cells in salamander, effects of dose on x, 25:58112
  scintigraphy for diagnosis of adenoma, effectiveness of iodine-131-labeled rose bengal and metastable technetium-99-labeled sulfur colloid for, 25:58046
  scintigraphy of neoplasms of human, uptake of gallium-67 citrate for, 25:58045
  scintigraphy of reticuloendothelial system function in patients with hematological diseases, use of metastable technetium-99 colloids for, 25:58053
  scintigraphy using metastable technetium-99-labeled sulfur colloids, diagnostic value of, 25:58060
  scintigraphy using selenium-75-labeled methionine for localization of lesions, 25:58054
  scintiscanning in mice, effects of pH on distribution of metastable indium-113 during, 25:58043
  scintiscanning of human, effectiveness of iodine-131-labeled triiodothyronine for, 25:58050
  tumor diagnosis in human, comparison of effectiveness of angiography, radioisotope scanning, and ultrasound tomography for, 25:58044
LOOPS
  design of sodium chemistry, 25:58163(R) (AI-AEC-12859)
  operation and performance of sodium supply, 25:58163(R) (AI-AEC-12859)
  operation for sodium quality control, development of methods for, 25:58166(R) (AI-AEC-12980)
  operation of forced-convection, for testing compatibility of Hastelloy N with molten MSRE coolant salts, 25:58168 (ORNL-4676, pp 139-233)
  operation of sodium, for fission product deposition studies, 25:58163(R) (AI-AEC-12859)
LOS ALAMOS MESON PHYSICS FACILITY
  development of, May--July 1971, 25:59641(R) (LA-4753)
  experimental facilities at, proposed use of CAMAC system for interfacing in, 25:59654
  experimental facilities for nuclear chemistry research, 25:59642 (LA-DC-12795)
  research program for, nuclear chemistry, 25:59642 (LA-DC-12795)
  research program, May--July 1971, 25:59641(R) (LA-4753)
LUBRICANTS
  performance of railroad equipment, use of radioisotopes for measuring, 25:57672
LUNAR MATERIALS
  classification of, (E), 25:58678
  composition and physical characteristics of, review of Apollo 11, 12, and 14 and Luna 16 data of, 25:58677
  mineralogy of, (E), 25:58678
  texture of, (E), 25:58678
LUNGS
  carcinomas of human, biology of in situ, 25:60269 (COO-1826-17)
  phagocytic response of in vitro cells from rat, effects of uranium oxide on, 25:57923
  plutonium contamination of human, multiwire proportional detector for measuring, 25:57773
  plutonium-239 deposition in human, development of large proportional and scintillation detectors for measurement of, 25:57998 (NIRS-Pu-8)
  plutonium-239 distribution studies of human, development of laminated lucite plate phantom for, 25:57998 (NIRS-Pu-8)
  radiation dose to human, following acute or chronic inhalation of insoluble plutonium-239, 25:58001 (UCRL-73388)
  radiation dose to human, following inhalation of cobalt-60-labeled cobalt oxide, 25:57995 (CONF-711013-1)
  radioinduced heterotopic bone formation in human, x, 25:58133
  radioinduced heterotopic bone formation in rabbit, effects of adrenocortical hormones on x, 25:58133
  radiotherapy of carcinomas of, review of complications and effectiveness in cobalt-60 γ and sieve and super-high voltage x, 25:58137
  scintigraphy for evaluation of blood perfusion, ventilation, and localization of neoplasms in human, 25:58040 (UCLA-12-834)
LUTETIUM
  determination in silicate rocks by neutron activation, low-energy photon detector for, 25:57387
  oxidation potential for trivalent--tetravalent, 25:57437
LUTETIUM ISOTOPES
  determination by neutron activation and γ spectroscopy, 25:57391
LYMPH NODES
  radiation dose to human pulmonary, following acute or chronic inhalation of insoluble plutonium-239, 25:58001 (UCRL-73388)
  radiation dose to human pulmonary, following inhalation of cobalt-60-labeled cobalt oxide, 25:57995 (CONF-711013-1)
LYMPH SYSTEM
  scintigraphy for localization of neoplasms, comparison between radiography and, 25:58055
LYMPHOCYTES
  chromosome aberration frequency in peripheral human, effectiveness as biological dosimeter of, 25:58013
  radiation effects on count and morphology of, from chronic lymphocytic leukemia patients following extracorporeal exposure of blood, electron microscopy of γ, 25:58131 (CEA-CONF-1768)
  radioinduced chromosome aberrations in human peripheral, review of, 25:57963
  radioinduced single-strand breaks in DNA of human, kinetics of repair of electron, 25:57958
LYNCHBURG TEST REACTOR
  control and protection system for, description of automatic-ranging picoammeter for, 25:57899
  protection system for, description of solid state instrumentation for, 25:60186
LYSINE
  radiation effects on metabolism in pea and wheat plants and their offspring, gamma, 25:57931
LYSOSOMES
  radiation effects on permeability of rat nervous system, x, 25:58098
  radiation effects on phospholipase A activity in dog sarcoma, γ, 25:57940

M

MACHINING
  dividing head angles in, use of INDEX 8 computer program in calculation of, 25:60273 (LA-4421)
  elctroerosion method for metals, 25:58193
MAGNESIUM
  determination in Roanoke River water by neutron activation and γ spectrometry, 25:57395
  effects on periodic precipitation in silver--cadmium alloys, 25:58262
  neutron elastic and inelastic scattering at 7.97 MeV by

natural, cross sections for, (E/T), 25:59770
- preparation of thin-film targets of, using Zapon temporary backing, 25:59639 (CONF-711002-, pp 134-43)
- proton reactions at 6 to 52 MeV with natural, cross sections for aluminum-26 and sodium-22 formation in, (E), 25:59753
- radioinduced void formation in, fast neutron, 25:58310

MAGNESIUM ALLOYS AND SYSTEMS
- Cd--Mg, hardness of, 25:58253
- Mg-base--Y, oxide particle identification in, after heat treatment in air, 25:58293

MAGNESIUM BROMIDES
- hexane--$\mathrm{MgBr_2}$, bromine-80m isomeric transition in, reactions of recoils from, 25:57494
- KBr--$\mathrm{MgBr_2}$, spectra at 400°C, Raman, 25:58387(R) (ANL-7823)

MAGNESIUM IODIDES
- KI--$\mathrm{MgI_2}$, spectra at 400°C, Raman, 25:58387(R) (ANL-7823)

MAGNESIUM IONS
- x-ray spectra of solar, (E), 25:58583

MAGNESIUM ISOTOPES Mg-23
- energy level at 451 keV, lifetime of, (E), 25:59719

MAGNESIUM ISOTOPES Mg-24
- abundance in solar atmosphere, (E), 25:58597
- alpha reactions (α,p) with, p-γ angular correlations from, (E), 25:59761
- deuteron inelastic scattering at 82 MeV, DWBA analysis of angular distributions from, (E), 25:59754
- energy levels from carbon-12 (O-16,α) reactions, negative-parity rotational, (E), 25:59767
- energy levels from electron inelastic scattering, model analysis of, (E/T), 25:59736
- energy levels of, calculation for α-hole, 25:59757
- production in stars from simple helium burning, (E), 25:58508

MAGNESIUM ISOTOPES Mg-25
- abundance in solar atmosphere, (E), 25:58597

MAGNESIUM ISOTOPES Mg-26
- abundance in solar atmosphere, (E), 25:58597

MAGNESIUM OXIDES
- ion transport numbers for, at 900 to 1180°C under low oxygen potentials, effects of ion radius on, 25:58379
- sintering of, parameters for activated, 25:58200
- vaporization of calcium oxide-stabilized, in air at 1900 to 2200°C, 25:58345
- MgO--CoO, preparation for high-temperature neutron dosimetry, 25:57723 (CONF-711002-, pp 82-5)
- MgO--polyethylene, radiation effects on mechanical properties and creep resistance of composites of, gamma, 25:58416(R) (RLO-2098-2)

MAGNET COILS
- design for thermonuclear torus device JFT-1, 25:59079

MAGNETIC ANALYZERS
- design of, using chromatic aberration in magnetic quadrupole lenses, 25:57901

MAGNETIC FIELDS
- charged particle motion in axially symmetric time-varying, (T), 25:59212
- effect on interacting electron gas, statistical mechanics of, (T), 25:59223
- effects of poloidal, on fundamental modes of oscillations of a polytrope, (T), 25:58507
- electrodynamics of planetary and stellar, Hall effect in, (T), 25:58849
- electron motion in uniform, synchrotron motion with radiation reaction for longitudinal velocity of, (T), 25:59359
- grain alignment by galactic, interstellar, (T), 25:58647
- lines of force in galactic, motion of, (T), 25:58657
- motions in sunspots, (E), 25:58598
- relation with magnetospheric substorm occurrences and solar-wind plasma parameters, (E), 25:58856
- strength of, in black holes, (T), 25:58498
- variations of, relation to magnetotail electron flux, magnetic activity, and radiation zone parameters, (E/T), 25:58852(T) (LA-tr-71-69)

MAGNETIC MATERIALS
- electron scattering by gaseous and solid, cross-section formulas for polarized-, 25:58687
- electrostatic interactions between magnetic electrons on neighboring ions in, temperature dependent, (T), 25:59189
- neutron diffraction polarization in scattering from, (T), 25:59681

MAGNETIC MIRROR MACHINES
- plasma equilibrium and confinement in DECA IIB, (E), 25:58958 (CEA-CONF-1807)
- plasma heating at second harmonic of electron cyclotron frequency, (E), 25:58971
- plasma heating by electron beam injection, (E), 25:58972
- plasma heating in Heliotron C, ohmic, (E), 25:58963
- plasma heating in, stochastic model of ECR, (T), 25:58968
- plasma trapping from atomic beam interactions with ECR-heated targets, (T), 25:58969

MAGNETIC MONOPOLES
- theory of atoms with magnetic charges as models of hadrons, 25:59447

MAGNETIC RECORDING SYSTEMS
- radiation effects on thin-film, gamma and neutron, 25:57908

MAGNETIC STORMS
- association with March 1970 solar particle event, observation over polar cap and in radiation belt, (E), 25:58892
- effect of Dec. 17, 1970, on conjugate magnetospheric pulsations and noise near plasmapause, (E), 25:58898
- effect on behavior of interplanetary plasma and magnetosphere, (E/T), 25:58886
- effects in ionosphere and magnetosphere, (T), 25:58865
- effects on electric-power systems operation, (E/T), 25:58887
- effects on geomagnetic-field daily variations, (E/T), 25:58874
- mechanism of polar, relation to electric coupling between magnetosphere and ionosphere, (E/T), 25:58909
- occurrence of magnetospheric substorms, relation with interplanetary magnetic-field and solar-wind plasma parameters, (E), 25:58856
- relation to atmospheric trough development at solar-activity maximum and minimum, (E), 25:58860
- relation to Pi2 micropulsation occurrences observed at high latitude, July 12-Aug.16, 1968, (E), 25:58903
- relation to variations in high-latitude trapping boundary of 100 to 200 keV protons, polar, (E), 25:58866
- relation with plasmapause position, electron-precipitation-associated, (E/T), 25:58897

MAGNETITES
- morphology and effects of coatings of, in boilers, 25:58165(T) (AEC-tr-7237)

MAGNETOHYDRODYNAMIC GENERATORS
- construction and operation of induction, with liquid-metal working fluid, 25:58840

MAGNETOHYDRODYNAMICS
- differential equations for, Algol system for solving, 25:59216

MAGNETOPAUSE
- plasma interaction with, parameters of interplanetary, (E/T), 25:58886
- proton trajectories at, using geomagnetic-field model, (E/T), 25:58861
- solar-wind plasma penetration to low altitudes through high-latitude cusp in, (E/T), 25:58882

MAGNETOSHEATH
- particle penetration to low altitudes through cusps of dayside magnetosphere, electron and proton, (E/T), 25:58882
- plasma interaction with, parameters of interplanetary, (E/T), 25:58886

MAGNETOSPHERE
- aerodynamic parameters of, satellite data-associated empirical determination of, (E/T), 25:58908
- charged-particle motion in core of, review of trapped, (E/T), 25:58910
- charged-particle occurrence at lower latitudes of trapping region boundary of, nonadiabatic behavior of, (E/T), 25:58907
- electric coupling with ionosphere, relation to polar magnetic disturbances and auroral break-up, (E/T), 25:58909
- electric currents in, quadrupole method for measurement of, (E/T), 25:58885
- electron precipitation from, correlation with vlf emissions and plasmapause position, (E/T), 25:58897
- magnetic-storm effects in, (T), 25:58865
- particle penetration to low altitudes through cusps of dayside, magnetosheath electron and proton, (E/T), 25:58882
- particle precipitation into high-latitude auroral zone from, patterns of energetic, 25:58896
- plasma instabilities in, review of, 25:58895
- plasma interaction with, parameters of interplanetary, (E/T), 25:58886
- properties of, review of, (E/T), 25:58910
- proton density associated with magnetic storms in, dynamics of thermal, (E), 25:58867
- proton trajectories at magnetopause and magnetotail using geomagnetic-field model, (E/T), 25:58861
- pulsations and noise analyses in conjugate, following Dec. 17, 1970 geomagnetic storm, (E), 25:58898
- radiation zone in, unstable, (E/T), 25:58906
- ring current in, location of, (T), 25:58854
- screening of cosmic instrumentation in, charge and potential from, (T), 25:59115
- variations in high-latitude trapping boundary of 100 to 200 keV protons associated with polar magnetic substorms, (E), 25:58866

MAGNETOTAIL
- electric flux of, relation to solar wind, magnetic activity, and radiation zone parameters, (E/T), 25:58852(T) (LA-tr-71-69)
- electromagnetic processes in, review of, (E/T), 25:58910
- plasma instabilities in plasma sheet in, review of, 25:58895
- plasma interaction with, parameters of interplanetary, (E/T), 25:58886
- proton trajectories at, using geomagnetic-field model, (E/T), 25:58861
- simulation using plasma in magnetic field of line dipole, (E/T), 25:58859

MAGNETS
  field calculations for, modified scalar potential in boundary-value problems in, 25:59647
MAINE YANKEE POWER REACTOR
  contol system for, design modifications of, 25:59899
  instrumentation for, design modifications of, 25:59899
  startup of, effects on regional power supply of delay in, 25:59956 (DOCKET-50271-63)
MAMMARY GLANDS
  radiation dose distribution in, during pendulum and tangential therapy, calculation and comparison of γ, 25:58003
  scintigraphy for localization of neoplasms, effectiveness of mercury-197, phosphorus-32, and selenium-75 for, 25:58051
MAN
  cobalt-60-labeled cobalt oxide biological half-life in, following inhalation, 25:57995 (CONF-711013-1)
  conference on neoplasms of intestine of, 25:58029
  epidermis thickness in relation to age, body site, and sex, 25:58000 (RD/B/R-1934)
  medical care following radiation accidents, program for regional, 25:58039
  plutonium hazards in, review, 25:57998 (NIRS-Pu-8)
  radiation dose field in hip and neck of, comparison of calculated and experimental proton, 25:58023
  radiation dose to brain of, during therapy of tinea capitis, use of Fricke dosimeter to measure absorbed x, 25:58012
  radiation dose to gonads and head of, during full-denture radiography using conventional and tomographic methods, 25:58022
  radiation dose to lungs and pulmonary lymph nodes of, following inhalation of cobalt-60-labeled cobalt oxide, 25:57995 (CONF-711013-1)
  radiation dose to lungs and pulmonary lymph nodes of, following acute and chronic inhalation of insoluble plutonium-239, 25:58001 (UCRL-73388)
  radiation dose to, during travel on high-altitude supersonic aircraft, ionizing, 25:58138
  radiation dose to, effectiveness of activation and biological detectors for measuring accidental exposure neutron, 25:58019
  radiation dose to, effectiveness of chromosome aberration frequency in peripheral lymphocytes for measuring low-level occupational, 25:58015
  radiation dose to, following accidental exposure to radium-226, use of chromosome aberration frequency in peripheral lymphocytes to calculate, 25:58016
  radiation dose to, from color television receivers in USA, estimation of genetically significant x, 25:58011
  radiation dosimetry in phantom of, isodose curves for whole-body γ and x, 25:58004
  radiation dosimetry in tissues of, concepts and units for ionizing, 25:58002
  radiation dosimetry in, effectiveness of chromosome aberration frequency in peripheral lymphocytes for, 25:58013
  radiation dosimetry in, effectiveness of chromosome aberration frequency in peripheral lymphocytes for, 25:58014
  radiation effects on blood vessels and heart in, following therapy for thoracic diseases, 25:58147
  radiation effects on cell division in epidermis of mammary tumors of, x, 25:58146
  radiation effects on central nervous system of, review of research on, 25:58143
  radiation effects on electrophoretic pattern of proteins in saliva of, 25:57945
  radiation effects on epithelium in, following therapy for cervical tumors, cytology and histology of γ, radium, and x, 25:58140
  radiation effects on excretion of catecholamines by, effects of ACTH on, 25:57938
  radiation effects on iodine-131 clearance rate in skin of, x, 25:58125
  radiation effects on lactate dehydrogenase activity in serum and vaginal tissues of, with cervical cancer, effects of dose on γ, 25:57937
  radiation effects on lymphocytes of, with lymphocytic leukemia following extracorporeal exposure of blood, γ, 25:58131 (CEA-CONF-1768)
  radiation effects on normal tissues of, during supervoltage radiotherapy, additive effects of antineoplastic drugs on, 25:58077
  radiation effects on reimplantation of mandible in, following surgical resection, x, 25:58132
  radiation effects on sensitivity to pharmaceuticals, ionizing, 25:58142
  radiation effects on survival of chromium-51-labeled erythrocytes of, in vivo following exposure in vitro, γ, 25:58136
  radiation effects on tumor surrounding tissues in, during therapy, effects of body inhomogeneities on electron and x, 25:58141
  radiation effects on, following therapy for cervical cancer, effects of adrenal cortex extract on, 25:58035
  radiation hazards to, in industry and medicine, review on, 25:58139
  radiodermatitis in, effectiveness of 5-fluorouracil for treatment of, 25:58037
  radioinduced chromosome aberrations in fibroblasts and lymphocytes of, effects of Fanconi's anemia on frequency of γ, 25:57973
  radioinduced chromosome aberrations in peripheral lymphocytes of, review of, 25:57963
  radioinduced heterotopic bone formation in lungs of, x, 25:58133
  radioinduced injuries to skin of, methods for treatment of, 25:58038
  radioinduced myocardial and pulmonary injuries in, following cobalt-60 γ and sieve and super-high voltage x radiotherapy of pulmonary carcinomas, review of, 25:58137
  radioisotope content of diet of, in EURATOM countries during 1969, 25:57979 (EUR-4667)
  radioisotope excretion and retention time following acute or chronic intake, cesium-137, iodine-131, iodine-132, plutonium-239, radium-226, strontium-90, tellurium-132, uranium-233, uranium-234, and tritium, 25:57919
  radioisotope uptake and retention in tissues of, development of radiation protection standards from data on, 25:58024 (CONF-711104-1)
  radiotherapy of adenomas of thyroid gland in, effectiveness of post-surgical interstitial iodine-131, 25:58056
  radiotherapy of breast neoplasms in, survival rate following post-surgical γ, 25:58071
  radiotherapy of breast neoplasms in, survival rate following pre-surgical gamma and x, 25:58073
  radiotherapy of carcinomas in, role of antitumor immune mechanisms of normal tissues in, 25:58072
  radiotherapy of carcinomas of skin of, effectiveness of x, 25:58068
  radiotherapy of gynecologic neoplasms in, occurrence of vesicovaginal fistula following, 25:58135
  radiotherapy of gynecological carcinomas in, effects of dose on injuries to bladder and rectum during cobalt-60 contact γ, 25:58010
  radiotherapy of neoplasms in, effectiveness of high-energy electron and x, 25:58076
  radiotherapy of tumor remnants in cervix uteri of, following external γ or x radiotherapy, effectiveness of small radiation sources for, 25:58074
  radiotherapy of tumors in, dose distribution planning for megavolt, 25:58007
MANGANESE
  content of foods in Kiev region of Soviet Union, 25:57987
  determination by extraction using quinolinol melt and spectrography, 25:57312
  determination in analytical reagents by neutron activation, 25:57379
  determination in Roanoke River water by neutron activation and γ spectrometry, 25:57395
  determination of trace amounts of, in tungsten trioxide or zirconium dioxide, effects of halide additives on direct spectrographic, 25:57335
  determination using sodium azide as supporting electrolyte, polarographic, 25:57307
  effects on hardness of dispersion-hardening iron-base alloys, 25:58235
  effects on niobium nitride solubility in iron austenite, 25:58268
MANGANESE ALLOYS AND SYSTEMS
  Al--Mn, structure of drops of, formed at high cooling rates, 25:58284
  C--Cr--Fe--Hf--Mn--Mo--Nb--Ni-base--Si--Ti--Zr, radiation effects on mechanical properties of, relations of composition with thermal neutron, 25:58168 (ORNL-4676, pp 139-233)
  Mn--Zr-base, properties of dilute cast, electric and mechanical, 25:58258
MANGANESE ISOTOPES Mn-52
  beta decay of, β--γ circular polarization correlations and Coulomb and Fermi matrix elements in, (E), 25:59746
MANGANESE ISOTOPES Mn-54
  content in Columbia River sediments, (E), 25:57561 (TID-25786)
MANGANESE ISOTOPES Mn-55
  photon reactions (γ,n) with, energy dependence of yield for, (E), 25:59815
MANGANESE OXIDES
  effects on structure of γ-irradiated sodium oxide--tellurium oxide glasses, EPR spectral studies on, 25:57447
MANY BODY PROBLEM
  angular momentum reduction in three-body problem, nonexhaustive restatement of, 25:59206 (LYCEN-7118)
  forces in, theory of two-body effective, (T), 25:59850
  Goldstone linked-cluster series in, factorization and folded diagrams in, 25:59865
  integral equations for d + n bound state and scattering problem for arbitrary-rank potential, derivation of coupled, (T), 25:59707
  localized states in phase space, (T), 25:59234
MARS (PLANET)
  ionosphere below 80 km, ion-chemistry model during solar-proton event, (T), 25:58676
MASS LAW
  application of Weizsaecker, to nuclei far from stability line, (E/T), 25:59836 (KURRI-TR-76, pp 3-6)

- MASS SPECTROMETERS
  - characteristics of on-line, tabulation of, 25:59835 (KURRI-TR-76, pp 1-2)
  - design of 60° sector, for gas analysis, 25:57890
  - design of, using chromatic aberration in magnetic quadrupole lenses, 25:57901
- MATERIALS TESTING, DESTRUCTIVE
  - methods for zirconium alloy fuel cladding and pressure tubes, 25:58209 (AECL-3992)
- MATHEMATICAL PHYSICS
  - eigenvalue problems for Lagrangian systems, 25:59052
  - factorization method in, 25:59227
  - Monte Carlo event generation method for multi-peripheral models, 25:59213
- MATRICES (MATHEMATICS)
  - bounds on bipartite graphs, 25:60274 (LA-4744)
- MATTER
  - forms of superdense, in stars, (T), 25:58520
  - pressure and temperature of, in Universe, (T), 25:58520
  - properties of ultradense, (T), 25:58432
- MATTER, ANTI-
  - annihilation radiation from, in meteor streams, (E), 25:58836
- MEATS
  - fish, radiation processing of, effects on toxicity in rats, 25:58162
- MECHANICS
  - analogies between statistical, and Euclidean quantum field theory, 25:59622
  - book: Scattering, Reactions, and Disintegrations in Nonrelativistic Mechanics (in Russian), 25:59612
- MEDICAL PERSONNEL
  - radiation effects on blood cell counts in, in Japan during 1969, survey of, 25:58134
  - radioinduced chromosome aberrations in, effects of dose, dose fractionation, and radiation source on γ, neutron, and x, 25:57972
- MEDICINE
  - book: Handbook for Technologists of Nuclear Medicine, 25:58049
  - personnel training programs for nuclear, 25:60263 (BRH/DMRE-71-5)
  - program for regional management of radiation accidents, 25:58039
  - radiation uses in, criteria for benefits and hazards of, 25:58030
- MEMBRANES
  - material transfer through, ideal tracer theory for, 25:60261 (BNL-50299)
- MENDELEVIUM
  - oxidation potential for trivalent--tetravalent, 25:57437
- MERCHANT VESSELS
  - construction of nuclear powered, radiation safety aspects of, 25:60204
  - design of nuclear powered, radiation safety aspects of, 25:60204
- MERCURY
  - abundance on surfaces of peculiar A stars, (E/T), 25:58462
  - beta-particle reactions with vapor of, mean energy for formation of ion pairs in, (E), 25:59123
  - determination in fish and other environmental samples by neutron activation and radiochemical separation, 25:57392
  - determination in fish, nuclear scattering method for, 25:57360
  - electron reactions with, excitation in, (E), 25:58741
  - preparation of thick samples of, by powder metallurgy, 25:58181 (CONF-711002-, pp 77-81)
- MERCURY (PLANET)
  - perihelion of, effects on differential rotation of Sun on advance of, (T), 25:58622
- MERCURY ALLOYS AND SYSTEMS
  - Hg-base--In, diffusion in, continuous resistivity monitoring in capillary-reservoir cell for measuring, 25:58210 (IS-T-490)
- MERCURY BROMIDES
  - hexane--$HgBr_2$, bromine-80m isomeric transition in, reactions of recoils from, 25:57494
- MERCURY, [(o-CARBOXYPHENYL)THIO]ETHYL-
  - sodium salt, radiosensitizing effects on Escherichia coli, γ, 25:58157
- MERCURY ISOTOPES
  - energy level transitions in, calculation of internal conversion coefficients for, (T), 25:59787
- MERCURY ISOTOPES Hg-197
  - evaluation of dichloride-incorporated, for scanning human mammary gland for localization of neoplasms, 25:58051
- MERCURY ISOTOPES Hg-203
  - beta decay of, beta--gamma angular correlations in, (E), 25:59795
- MESIC ATOMS
  - energy-level transitions in μ^- and π^-, cascade processes and x-ray emission in, (T), 25:58724
  - production of π^-, from electron reactions with nuclei, 25:59355
- MESONS
  - classification in ladder U(6,6) symmetry, (T), 25:59546
  - classification in representations of SU(4) x O(3) group, 25:59551
  - coupling to photons, Veneziano-type representations for, (T), 25:59352
  - decay of, model with intermediate vector meson for total radiative corrections to G/sub β//supV//G/sub μ/ ratio for, (T), 25:59416
  - decays of, relation between soft-pion mass and amplitudes for leptonic, 25:59399
  - exchange in interactions of two spinless bosons, radiative corrections to relativistic eikonal amplitude for, (T), 25:59453
  - exchange of vector, in N + N interactions, radiative corrections to relativistic eikonal amplitude for, (T), 25:59453
  - existence of I = 2, relation of selection rules for weak interactions to, 25:59393
  - field theory for massive vector, gauge-invariant Lagrangian for electromagnetic and quantum, (T), 25:59555
  - interactions of equal-mass scalar, localizability and single-particle exchange amplitudes for, 25:59454
  - interactions with $1/2^+$ baryons, spin amplitudes for pseudoscalar meson $1/2^+$ baryon production in, (T), 25:59471 (CEA-N-1456)
  - interactions with baryons, consistency conditions between SU(3) and exchange degeneracy in, 25:59493
  - interactions with baryons, polarization predictions from double Regge pole exchange for, 25:59503
  - interactions with mesons and baryons at high energies, relation of coherent state method with quark models for, (T), 25:59448 (JINR-E2-6025)
  - interactions with mesons and baryons in nonchiral U(6) x U(6), duality diagrams and representation mixing for, 25:59549
  - interactions with spinless bosons, radiative corrections to relativistic eikonal amplitude for scalar meson exchange in elastic, (T), 25:59453
  - mass formulas in ladder U(6,6) symmetry, (T), 25:59546
  - production of scalar, in γ + N interactions, classical charge-symmetric field theory for cross sections for, (T), 25:59338
  - production of vector, simultaneously with $\Sigma^-(1385)$ in Λ and Σ^0 four-body final states in K^- + n interactions at 4.48 GeV/c in deuterium bubble chamber, spin-density matrix elements for, (E), 25:59280
  - quantum field theory for spin-two, LSZ formulation of, 25:59570
- MESONS (eta)
  - decay eta $\to 2\pi + \gamma$, hard-meson current algebra and PCAC model for width of, 25:59443
  - decay eta $\to 3\pi$, linear SU(3) sigma model for correlation between baryon $\Delta I = 1$ mass shifts, K mass shift and, 25:59380
  - decay eta $\to 3\pi^0$ in heavy-liquid bubble chamber, branching ratio and amplitude for, (E), 25:59244
  - decay eta $\to \gamma + \gamma$ from production in $e^+ + e^-$ interactions, proposed experimental study of, 25:59253
  - decay eta $\to \gamma\gamma$ in heavy-liquid bubble chamber, branching ratio for, (E), 25:59244
  - decay eta $\to \pi^+ + \pi^- + \pi^0$ in heavy-liquid bubble chamber, analysis of, (E), 25:59244
  - mass and width in five- and six-charged-particle final states in π^+ + d interactions at 2.7 and 3.1 GeV/c in bubble chamber, (E), 25:59282
  - mixing angle for eta and eta' in five- and six-body final states in π^+ + d interactions at 2.7 and 3.1 GeV/c in bubble chamber, SU(3), (E), 25:59282
  - mixing of eta and X^0 for cross sections of $e^+ + e^- \to$ eta(X^0) + γ interactions in vector meson region, linear and quadratic, (T), 25:59377
  - production in $e^+ + e^- \to e^+ + e^-$ + eta, eta $\to \gamma + \gamma$ interactions, cross sections for, 25:59389
  - production in five- and six-charged-particle final states in π^+ + d interactions at 2.7 and 3.1 GeV/c in bubble chamber, (E), 25:59282
  - production of eta^0 in $e^+ + e^- \to$ eta^0 + γ interactions in vector meson region, vector dominance model with linear and quadratic mixing of eta and X^0 for cross sections of, (T), 25:59377
- MESONS (f)
  - decay of interfering f--background, statistical tensors for angular distributions of, 25:59461
  - production in anti p + p $\to 2\pi^+ + 2\pi^-$ interactions at 2.5 GeV/c, (E), 25:59271
- MESONS (K)
  - decay K $\to 2\pi$, violation of $\Delta I = {}^1/_2$ rule in, 25:59405
  - decay K $\to 3\pi$, violation of $\Delta I = {}^1/_2$ rule in, 25:59405
  - decay K $\to \pi + l + \nu$, bounds on form factors of, 25:59411
  - decay K $\to \pi + l + \nu$, lower bound on lambda/sub +/ in, (T), 25:59392 (ORO-3992-69)
  - decay of, model with intermediate vector meson for total radiative corrections to G/sub β//supV//G/sub μ/ ratio for, (T), 25:59416
  - interactions anti K + N at 0 to 1400 MeV/c, energy-dependent multichannel M-matrix fits to partial-wave analyses of, (T), 25:59476
  - interactions K + N, empirical analysis of differences and sums of angular distributions for duality in, (T), 25:59477
  - interactions K + N, modified Pomeranchuk theorem for lower bounds on elastic and charge-exchange, 25:59474
  - interactions K + $\pi \to$ K + π in K^- + d $\to K^- + \pi^-$ + 2p interactions at 12.6 GeV/c, cross sections for, (E), 25:59283

XUM

  interactions $K + \pi$ from $K^+ + p \to K^0(K^+) + \pi^0(\pi^-) + \Delta^{++}$ interactions at 2.5 to 5.0 GeV, rotation of symmetry axis in, 25:59502
  interactions $K + \pi$, CDD poles in effective range formula for form factors of, 25:59466
  interactions $\pi + K$, exact inequalities involving S- and P-wave partial-wave amplitudes and derivatives for, (T), 25:59452
  mass shift of, linear SU(3) sigma model for correlation between eta $\to 3\pi$ decay, octet baryon $\Delta I = 1$ mass shifts, and, 25:59380
  theory for KN system, quasipotential formalism for field-theoretic and phenomenological analysis in, (T), 25:59422 (JINR-E2-6046)
MESONS (K^-)
  interactions $K^- + d \to K^- + d$ at 810 to 1110 MeV/c, angular distributions for, (E), 25:59302
  interactions $K^- + d \to K^- + p + n$ at 810 to 1110 MeV/c, angular distributions for, (E), 25:59302
  interactions $K^- + d \to K^- + \pi^- + 2p$ at 12.6 GeV/c, production of $p\pi^-(1450)$ enhancement, cross sections for $K + \pi \to K + \pi$ interactions, production cross sections for Ξ^- and Ω^-, and cross sections for, (E), 25:59283
  interactions $K^- + d \to K^- + \pi^+ + \pi^- + n + p$ at 12.6 GeV/c, production of $n\pi^+\pi^-(1450)$ and $p\pi^+\pi^-(1450)$ enhancements, production cross sections for Ω^- and Ξ^-, and cross sections for, (E), 25:59283
  interactions $K^- + d \to \pi^- + \Lambda + p$, Λp mass spectra in, 25:59522
  interactions $K^- + N \to \Lambda + \pi$ at 1 to 1.85 GeV/c, partial-wave analysis of, (E), 25:59303
  interactions $K^- + n \to \pi^- + \Lambda$ and $\pi^+ + n \to K^+ + \Lambda$, duality and exchange degeneracy from finite-energy sum rules for, 25:59501
  interactions $K^- + n$ at 3 GeV/c, differential cross sections for two-body, (E), 25:59291
  interactions $K^- + n$ at 4.48 GeV/c in deuterium bubble chamber, $\Sigma(1640)$ and A_2 production, and simultaneous production of vector mesons and $\Sigma^-(1385)$ in Λ and Σ^0 four-body final states in, (E), 25:59280
  interactions $K^- + n$ at 810 to 1110 MeV, angular distributions for elastic, (E), 25:59302
  interactions $K^- + N$ at intermediate energy, dual structure of amplitudes for, 25:59504
  interactions $K^- + p \to$ anti $K^0 + n$ at 800 to 1200 MeV/c, partial-wave analysis of, (E/T), 25:59293
  interactions $K^- + p \to$ anti $K^0 + n$, test of semi-local duality in backward, (E), 25:59482
  interactions $K^- + p \to K + \Xi$ at 2 to 5 GeV/c, Regge cut model for near-forward differential cross sections for, 25:59483
  interactions $K^- + p \to K^- + p$ at 800 to 1200 MeV/c, partial-wave analysis of, (E/T), 25:59293
  interactions $K^- + p \to K^- + \pi^0 + p$, dual + Pomeron analysis of, 25:59490
  interactions $K^- + p \to K^+ + \Xi^-$ at high energies, two-Reggeon cuts and exotic exchange in, (T), 25:59618
  interactions $K^- + p \to K^-$(anti K^0) + p(n) near 1.670 GeV in hydrogen bubble chamber, differential cross sections for, (E), 25:59281
  interactions $K^- + p \to \Lambda(\Sigma^0) + \pi^+ + \pi^-$ at 3.9 to 5.0 GeV/c in hydrogen bubble chamber, Σ^{+*} production in, (E), 25:59284
  interactions $K^- + p \to p + \pi^- +$ anti K^0 at 3.9 to 5.0 GeV/c in hydrogen bubble chamber, Σ^{+*} production in, (E), 25:59284
  interactions $K^- + p \to p + \pi^- +$ anti K^0 at 4.6 and 5.0 GeV/c in hydrogen bubble chamber, quasi-two-body cross sections for, (E), 25:59284
  interactions $K^- + p \to \pi^- + \pi^+ + \Lambda$, Veneziano five-point function model for, 25:59488
  interactions $K^- + p \to \pi^+ + \Sigma^-$ at 2 to 16 GeV/c, Regge cut model for near-forward differential cross sections for, 25:59483
  interactions $K^- + p$ at 4.6 and 5.0 GeV/c in hydrogen bubble chamber, quasi-two-body cross sections for production of two charged particles and $\Lambda(\Sigma^0)$ in, (E), 25:59284
  interactions $K^- + p$, empirical analysis of differences and sums of angular distributions for, (T), 25:59477
  production in $p + p$ interactions at 14.25 to 70 GeV/c, phenomenological study of inclusive single-particle spectra in triple Regge limit for, (T), 25:59505 (JINR-E2-6031)
MESONS (K^0)
  CP violation in (K^0--anti K^0) system, second-order weak effect for parameters of, (T), 25:59540
  decay $K_1^0 \to 2\gamma$, search for, (E), 25:59264
  decay $K_1^0 \to 2\pi$, dispersion relations, current algebra, and PCAC for, 25:59409
  decay $K_1^0 \to \mu^+ + \mu^-$, rate of, 25:59419
  decay $K_1^0 \to \pi^+ + \pi^- + \pi^0$, spark chamber study of CP violation in, (T), 25:59259
  decay $K_2^0 \to 2\gamma$, branching ratio for, (E), 25:59264
  decay $K_2^0 \to 2\gamma$, CP-violating rate for, 25:59419
  decay $K_2^0 \to \mu^+ + \mu^-$, CP violation in, 25:59544
  decay $K_2^0 \to \mu^+ + \mu^-$, rate of, 25:59419
  decay $K_2^0 \to \mu^+ + \mu^-$, T invariance in unitarity limit of, 25:59543
  decay $K_2^0 \to \pi^+ + \pi^- + \gamma$, CP-violating rate for, 25:59419
  decay $K_2^0 \to \pi^+ + \pi^- + \pi^0$, spark chamber study of Dalitz plot for test of $\Delta I = {}^1/_2$ rule and CP conservation in, (E), 25:59258
  decay of, equivalence of Lee--Sugawara sum rules and selection rules for nonleptonic, 25:59396
  interactions $K_2^0 + p \to K_1^0 + p$ at 3 and 6 GeV/c, empirical analysis of differences and sums of angular distributions for, (T), 25:59477
  interactions $K_2^0 + p \to K_1^0 + p$ at high energies, asymptotical properties of amplitude of, (T), 25:59494
MESONS (anti K^0)
  interactions anti $K^0 + N \to K + \Xi$ at 2 to 5 GeV/c, Regge cut model for near-forward differential cross sections for, 25:59483
MESONS (K^+)
  decay $K^+ \to e + \nu$, test of V--A theory of weak interactions in spark chamber study of branching ratio for, (E), 25:59256
  decay $K^+ \to \pi + \pi + e + \nu$, low-energy $\pi\pi$ phase shifts and form factors from, 25:59263
  decay $K^+ \to \pi^+ + \pi^+ + e^- +$ anti ν, test of $\Delta S = \Delta Q$ rule in, (E), 25:59262
  decay $K^+ \to \pi^+ + \pi^- + e^+ + \nu$, rate of, (E), 25:59262
  interactions $K^+ + N \to K^0 + p + p$ at 5.5 GeV/c, partial cross section and momentum transfer distribution for, (E), 25:59305
  interactions $K^+ + n \to K^+ + \pi^- + p$ and $K^+ + n \to K^0 + \pi^+ + \pi^- + p$ at 9 GeV/c in deuterium bubble chamber, cross sections and mass spectra from, (E), 25:59318
  interactions $K^+ + n \to K^+ + \pi^- + p$ at 3 GeV/c, unitarized Veneziano model for, 25:59478
  interactions $K^+ + p \to$ anti $\Lambda + p + p$ at 8.25 GeV/c, Veneziano model for, (E/T), 25:59295
  interactions $K^+ + p \to$ anti $\Sigma^0 + p + p$ at 8.25 GeV/c, cross sections for, (E), 25:59295
  interactions $K^+ + p \to K^0 + \pi^0 + \Delta^{++}$ at 2.5 to 5.0 GeV, rotation of symmetry axis in $K + \pi$ interactions from, 25:59502
  interactions $K^+ + p \to K^+ + \pi^0 + p$, dual + Pomeron analysis of, 25:59490
  interactions $K^+ + p \to K^+ + \pi^- + \Delta^{++}$ at 2.5 to 5.0 GeV, rotation of symmetry axis in $K + \pi$ interactions from, 25:59502
  interactions $K^+ + p$ at 5 GeV/c, cross sections and angular correlations for six- and seven-body states in, (E), 25:59299
  interactions $K^+ + p$ at 8.25 GeV/c, cross sections for Y^* and N^* production in, (E), 25:59295
  interactions $K^+ + p$ below 600 MeV/c, s- and p-wave scattering lengths for, (T), 25:59489
  interactions $K^+ + p$, empirical analysis of differences and sums of angular distributions for, (T), 25:59477
  production in $p + p$ interactions at 14.25 to 70 GeV/c, phenomenological study of inclusive single-particle spectra in triple Regge limit for, (T), 25:59505 (JINR-E2-6031)
MESONS (μ)
  capture by atoms, cascade processes and x-ray emission in, (T), 25:58724
  decay of polarized, electron energy spectrum from, 25:59404
  decay of, two- and four-component neutrino theories from, (T), 25:59407
  energy losses of 10^5- to 10^8-MeV, in matter, numerical solutions to kinetic equation for, (T), 25:59400
  intensity and distribution in cosmic showers underground, 25:59247
  intensity of cosmic, absolute, (E), 25:58826
  intensity variations of primary and secondary cosmic, at high energies, 25:58827
  interactions of cosmic, at large zenith angles at sea level, electromagnetic, 25:59343
  interactions to 1 TeV of cosmic, cross sections for electromagnetic, (E), 25:59246
  production from kaon and pion decay in atmosphere, trivial, (E/T), 25:58828
  production in cosmic $\nu + N$ interactions at high energies, spectra for, (T), 25:59417
  spectra of 20- to 1000-GeV cosmic, at sea level, 25:59245
MESONS (μ^-)
  capture by calcium and sulfur, asymmetry coefficient for low-energy neutron angular distribution from, (E), 25:59738 (JINR-P1-6029)
  capture by gaseous hydrogen, field theoretical basis for weak-interaction theory for, (T), 25:59397
  capture by helium-3, elementary particle treatment of, (T), 25:59397
  production in $\nu + N \to \mu^- + W^+ + N$ interactions and ν reactions with iron, angular and momentum distributions for, (T), 25:59414
  spectra from neutrino reactions (ν,μ^-W^+) with nuclei and $W \to \mu + \nu$ decay, 25:59410
MESONS (μ^+)
  decay $\mu^+ \to e^+ + e^+ + e^-$, spark chamber study of upper limit for branching ratio for, (E), 25:59254(T) (BNL-tr-449)
  emission in $W^+ \to \mu^+ + \nu$ decay, angular and momentum distributions for, (T), 25:59413
  production in neutrino reactions with iron, angular and momentum distributions for, (T), 25:59415
  production in neutrino reactions with nuclei, angular and momentum distributions for, (T), 25:59415

XUM

- decay $\omega \to 2\pi$, interference of rho $\to \pi^+ + \pi^-$ with, 25:59552
- decay $\omega \to 3\pi$, hard-meson current algebra and PCAC model for width of, 25:59443
- decay $\omega \to$ eta + $\gamma/\omega \to$ neutrals, branching ratio for, (E), 25:59320
- decay $\omega \to \pi^0 + \gamma$, branching ratio for, (E), 25:59320
- decay $\omega \to \pi^0 + \pi^0 + \gamma/\omega \to$ neutrals, branching ratio for, (E), 25:59320
- decay $\omega \to \pi^+ + \pi^- + \pi^0$ from $\pi^+ + p \to \pi^+ + p + \omega$ interactions at 3.7 GeV/c, charge asymmetry on Dalitz plot of, (E), 25:59308
- decay $\omega \to \pi^+ + \pi^- + \pi^0$, charge asymmetry in Dalitz plot of, 25:59468
- decay $\omega \to \pi^+ + \pi^- + \pi^0$, search for C violation from rho^0 interference in, 25:59552
- exchange contributions to $\gamma + d \to$ eta + d interactions, amplitudes with anomalous thresholds for, (t), 25:59514
- interference with rho in photoproduction processes, phase of rho propagator in, 25:59348
- mass and width in five- and six-charged-particle final states in $\pi^+ + d$ interactions at 2.7 and 3.1 GeV/c in bubble chamber, (E), 25:59282
- mixing of rho--ω in photon reactions (γ, e^+e^-) with nuclei, vector dominance model for, 25:59364
- photoproduction on carbon-12 at 4 GeV, relative rho--ω phase in, (E), 25:59252
- production in five- and six-charged-particle final states in $\pi^+ + d$ interactions at 2.7 and 3.1 GeV/c in bubble chamber, (E), 25:59282

MESONS (phi)

- decay phi $\to 3\pi$, hard-meson current algebra and PCAC model for width of, 25:59443
- decay rho $\to \mu^+ + \mu^-$, branching ratio for, (E), 25:59310
- mass and width from $\pi^- + p \to K^+ + K^- + n$ interactions at 11.04 GeV/c in optical spark chamber, (E), 25:59301

MESONS (π)

- capture by atoms, cascade processes and x-ray emission in, (T), 25:58724
- form factor for, Veneziano-type representations for, (T), 25:59352
- form factors from current algebra, Regge poles, and Veneziano model, axial-vector, 25:59356
- interactions $A + \pi \to A + \pi$, Veneziano amplitude for, (T), 25:59464
- interactions $\gamma + \pi \to \pi + \pi$, hard-meson current algebra and PCAC model for γ--3π coupling constant and form factor for, 25:59382
- interactions $K + \pi \to K + \pi$ in $K^- + d \to K^- + \pi^- + 2p$ interactions at 12.6 GeV/c, cross sections for, (E), 25:59283
- interactions $K + \pi$ from $K^+ + p \to K^0(K^+) + \pi^0(\pi^-) + \Delta^{++}$ interactions at 2.5 to 5.0 GeV, rotation of symmetry axis in, 25:59502
- interactions $K + \pi$, CDD poles in effective range formula for form factors of, 25:59466
- interactions of, nonlinear sigma model for six-point function for, 25:59456
- interactions $\pi + K$, exact inequalities involving S- and P-wave partial-wave amplitudes and derivatives for, (T), 25:59452
- interactions $\pi + \Lambda \to \pi + \Lambda$ in Veneziano model, positive width and S-wave scattering length in, 25:59473
- interactions $\pi + N \to$ eta + N, dispersion theoretic model for $S_{11}(1525)$ resonance and cross sections for, 25:59486
- interactions $\pi + N \to m\pi + N$, one-pion-exchange model for effective mass spectrum of π system in, (T), 25:59496
- interactions $\pi + N \to \pi + \Lambda + K$ at 7 GeV/c, production of N*(1700) in, 25:59307
- interactions $\pi + N$ at high and superhigh energies, Monte Carlo method with energy--momentum conservation law for analytical approximations for reconstruction of inelastic, (T), 25:59472 (JINR-P2-6022)
- interactions $\pi + N$ at threshold to 13 GeV/c, predictions of isospin invariance in backward, (E/T), 25:59287
- interactions $\pi + N$ in pre-asymptotic region, angular distributions and amplitude structure for inelastic, (T), 25:59457
- interactions $\pi + N$, complex Regge poles in backward, (T), 25:59495
- interactions $\pi + N$, generalized potential and P_{33} phase shift for, 25:59485
- interactions $\pi + N$, invariant amplitudes in unphysical region for, 25:59481
- interactions $\pi + N$, low-energy $\pi + \pi$ interaction from phase shifts for, 25:59463
- interactions $\pi + N$, modified Pomeranchuck theorem for lower bounds on cross sections for elastic, 25:59474
- interactions $\pi + N$, parity violation from longitudinal polarization of recoil nucleon in, 25:59487
- interactions $\pi + N$, reconstruction of amplitudes from experimental data for, 25:59498
- interactions $\pi + p$ at high energies, experimental test of Pomeranchuk theorem in, 25:59424
- interactions $\pi + \pi$ at high energies, two-Reggeon cuts and exotic exchange in, 25:59618
- interactions $\pi + \pi$ from elastic πN phase shifts, low-energy, 25:59463
- interactions $\pi + \pi$ from $\pi^+ + p \to \Delta^{++} + \pi^+ + \pi^-$ interactions at 8 GeV/c, S-wave resonance effects in, (E/T), 25:59296
- interactions $\pi + \pi$ from $\pi^- + p \to \pi^+ + \pi^- + n$ interactions, S-wave phase shift for, (E), 25:59306
- interactions $\pi + \pi$ in current algebra, bootstrap of rho and sigma from amplitudes for, 25:59469
- interactions $\pi + \pi$, CDD poles in effective range formula for form factors of, 25:59466
- interactions $\pi + \pi$, effective chiral Lagrangians from current-algebra calculations of off-shell amplitude for, 25:59455
- interactions $\pi + \pi$, finite energy sum rules for Veneziano amplitude of, 25:59450
- interactions $\pi + \pi$, phase shifts and form factors from $K^+ \to \pi + \pi + e + \nu$, 25:59263
- interactions $\pi + \pi$, S-wave phase shift in model of SU(3) x SU(3) symmetry breaking, 25:59550
- interactions $\pi + \pi$, scattering lengths from chiral invariant Lagrangian with massive gauge fields for, 25:59449
- interactions $\pi + \pi$, unitarity sum rule in Veneziano model for, 25:59462
- production in bound state in electron reactions with nuclei, 25:59355
- production in $\gamma + N \to \pi + N$ interactions, vector meson dominance of k^2 dispersion relation for invariant amplitudes for, (T), 25:59351
- production in proton reactions with iron at 400 GeV, Monte Carlo calculations of star and flux distributions from, (T), 25:59507 (ORNL-4673)
- production in $\pi + N \to m\pi + N$ interactions, one-pion-exchange model for effective mass spectrum for, (T), 25:59496
- radius of, $\pi^+ \to e^+ + \nu + e^+ + e^-$ decay for electromagnetic, (T), 25:59412
- ratio to protons at altitudes of 800 gm/cm^2, non EAS-associated, (E), 25:58834
- reactions with nuclei at 0.01 to 100 GeV, cascade evaporation model for Monte Carlo method for calculating, (T), 25:59508(T) (ORNL-tr-2514)
- reactions with nuclei, absorption and dispersion corrections to πN optical potential for, 25:59516
- Regge trajectory and residues for, 25:59460
- scattering by carbon-12 at 120 to 1200 MeV, angular distribution and total cross section for, (T), 25:59712
- theory for πN system, quasipotential formalism for field-theoretic and phenomenological analysis in, (T), 25:59422 (JINR-E2-6046)

MESONS (π^-)

- capture by carbon-12, calculation using impulse approximation with Cohen-Kurath wave functions, (T), 25:59730
- decay $\pi^- \to \mu^- +$ anti ν, mass of ν from μ^- polarization in, 25:59257
- interactions $\pi^- + d$ at 9 GeV/c, Glauber multiple scattering model for elastic, (E/T), 25:59269
- interactions $\pi^- + p \to A_2^- + p$ at 3.9 and 16 GeV/c in bubble chamber, A_2^- production mechanism in, (E), 25:59279
- interactions $\pi^- + p \to$ eta + n at 1.6 and 2.3 GeV/c, angular distribution predictions for, (T), 25:59477
- interactions $\pi^- + p \to$ eta + n, complex A_2 Regge trajectory for analyzing, (T), 25:59479
- interactions $\pi^- + p \to K^0 +$ anti $K^0 + n$ at 12 GeV/c, generalized Veneziano model for, (T), 25:59492
- interactions $\pi^- + p \to K^+ + K^- + n$ at 11.04 GeV/c, mass and width of phi from optical spark chamber study of, (E), 25:59301
- interactions $\pi^- + p \to K^+ + \Sigma^-$ at 2 to 16 GeV/c, Regge cut model for near-forward differential cross sections for, 25:59483
- interactions $\pi^- + p \to \Lambda^0 + K^0$, $\Lambda^0 \to p + \pi^-$ at 1.07 GeV/c, Λ^0 magnetic moment from, (E), 25:59294
- interactions $\pi^- + p \to n + \pi^+ + \pi^-$ at 7 GeV/c, production of $g^0(1670)$ in, (E), 25:59288
- interactions $\pi^- + p \to n + X^0$, $X^0 \to \gamma + \gamma$ at 1.6 GeV/c, (E), 25:59290
- interactions $\pi^- + p \to p + MM^-$ at 3.25 GeV/c with high momentum transfer, differential cross sections for rho$^-$ production in, (E), 25:59312
- interactions $\pi^- + p \to p + \pi^+ + \pi^- + \pi^- + \pi^0$ at 13 and 20 GeV/c, multi-Regge model for, (E/T), 25:59300
- interactions $\pi^- + p \to \pi^0 + n$ at 2 to 5 GeV/c, partial wave amplitudes for, (E/T), 25:59304
- interactions $\pi^- + p \to \pi^0 + n$ at 3.67 and 4.83 GeV/c, Regge trajectory and isospin invariance in, (E), 25:59289
- interactions $\pi^- + p \to \pi^- +$ anything at 8 to 24.8 GeV/c in bubble chamber, cross sections for, (E), 25:59319
- interactions $\pi^- + p \to \pi^- + p$ at 3.0 to 5.0 GeV/c and 55 to 130°, scintillation counter and spark chamber study of angular distributions for, (E), 25:59285
- interactions $\pi^- + p \to \pi^- + p$, spin amplitudes for, (T), 25:59471 (CEA-N-1456)
- interactions $\pi^- + p \to \pi^+ + \pi^- + n$, S-wave $\pi\pi$ phase shift from, (E), 25:59306
- interactions $\pi^- + p \to \pi^- + \pi^- + \pi^+ + p$ at 7 and 25 GeV/c, production and decay of N*(1500) and N*(1700) in, 25:59307
- interactions $\pi^- + p \to$ rho^0 + n at 11 GeV/c, Regge-pole

  analysis of, (E/T), 25:59499
  interactions $\pi^- + p \to \text{rho}^0 + n$ at 7 GeV/c in bubble chamber, angular distributions from, (E), 25:59286
  interactions $\pi^- + p$ at 2 to 5 GeV/c, partial wave amplitudes for elastic, (E/T), 25:59304
  interactions $\pi^- + p$ at 3.25 GeV/c in hydrogen bubble chamber, rho$^-$ and rho^0 peripheral production cross sections and cross sections for two-prong, (E), 25:59314
  production in $p + p$ interactions at 14.25 to 70 GeV/c, phenomenological study of inclusive single-particle spectra in triple Regge limit for, (T), 25:59505 (JINR-E2-6031)
  reactions $(\pi^-, 2\pi^-\pi^+)$ and $(\pi^-, 3\pi^- 2\pi^+)$ with nuclei at 17 and 45 GeV in emulsions, mean free paths for coherent, (E), 25:59313
  reactions with light nuclei at 4 GeV/c in freon bubble chamber, cross sections and mass distributions for coherent production of $\pi^+2\pi^-$ system in, (E), 25:59316
  scattering by bromine and silver at 3.5 GeV/c with charged-particle evaporation, charged-particle energy spectra and angular distributions for inelastic, (E), 25:59822
  scattering by carbon-12 at 120 to 260 MeV, Coulomb--nuclear interference and differential cross sections for elastic, (E), 25:59713
  scattering by carbon-12 at 180 MeV, Glauber approximation for differential cross sections for elastic, 25:59523
  scattering by helium-4, contribution of multiple scattering to total cross section for, 25:59524
MESONS (π^0)
  decay $\pi^0 \to 2\gamma$, relation between amplitudes for $\gamma + \gamma \to 3\pi$, $e^+ + e^- \to 3\pi$, and, 25:59357
  decay $\pi^0 \to \gamma + \gamma$ from production in $e^+ + e^-$ interactions, proposed experimental study of vertex for, 25:59253
  decay $\pi^0 \to \gamma + \gamma$, $\pi^+ \to e^+ + \nu + e^+ + e^-$ decay for amplitude of, 25:59412
  interactions $\pi^0 + \pi^0 \to \pi^0 + \pi^0$ constraints imposed by analyticity, crossing, and positivity on s- and d-wave, 25:59458
  interactions $\pi^0 + \pi^0$ below threshold, lower bound on amplitude for, 25:59459
  production in $e + e$, $e + p$, and $p + p$ interactions, two-photon generation mechanism for angular distributions and cross sections for, (T), 25:59370
  production in $e + p \to e + \pi^0 + p$ interactions, differential cross sections for, (E), 25:59353
  production in $e^+ + e^- \to e^+ + e^- + \pi^0$, $\pi^0 \to \gamma + \gamma$ interactions, cross sections for, 25:59389
  production in $e^+ + e^- \to \pi^0 + \gamma$ interactions in vector meson region, vector dominance model for cross sections for, (T), 25:59377
  production in $\gamma + N \to \pi^0 + N$ interactions, PCAC hypothesis from s-wave threshold amplitudes of, (E/T), 25:59373
MESONS (π^+)
  decay $\pi^+ \to e^+ + \nu + e^+ + e^-$, ratio of axial to vector form factor for $\pi^+ \to e^+ + \nu + \gamma$ decay, π electromagnetic radius, and sign of $\pi^0 \to \gamma + \gamma$ amplitude from, (T), 25:59412
  decay $\pi^+ \to e^+ + \nu + e^+ + e^-$, spark chamber study of upper limit for branching ratio for, (E), 25:59255(T) (BNL-tr-451)
  decay $\pi^+ \to e^+ + \nu + \gamma$, $\pi^+ \to e^+ + \nu + e^+ + e^-$ decay for ratio of axial to vector form factor for, (T), 25:59412
  decay $\pi^+ \to e^+(\mu^+) + e^+ + e^- + \nu$, integral probability for, (T), 25:59412
  interactions $\pi^+ + d \to d + \pi^+ + \pi^+ + \pi^-$ at 13 GeV/c, dual diffractive model for, (E/T), 25:59480
  interactions $\pi^+ + d \to p + p + \pi^+ + \pi^-$ at 7 GeV/c, production of $g^0(1670)$ in, (E), 25:59288
  interactions $\pi^+ + d \to$ p/sub s/ $+ p + \pi^+ + \pi^- + \pi^0$ at 7.0 GeV/c, production and decay of N*(1500) and N*(1700) in, 25:59307
  interactions $\pi^+ + d \to \pi^+ + d$ at 40 and 60 MeV, use of impulse approximation for calculation of differential cross sections for, (E), 25:59484
  interactions $\pi^+ + d \to \pi^+ + n + p$ at 40 and 60 MeV, use of impulse approximation for calculation of differential cross sections for, (E), 25:59484
  interactions $\pi^+ + d$ at 2.7 and 3.1 GeV/c in bubble chamber, resonance production in five- and six-charged-particle final states in, (E), 25:59282
  interactions $\pi^+ + n \to K^+ + \Lambda$ and $K^- + n \to \pi^- + \Lambda$, duality and exchange degeneracy from finite-energy sum rules, 25:59501
  interactions $\pi^+ + n \to \text{rho}^0 + p$ at 7 GeV/c in bubble chamber, angular distributions from, (E), 25:59286
  interactions $\pi^+ + p \to 2\pi^+ + \pi^- + p$ at 5 GeV/c, analysis of angular distributions in A_1 and A_2 regions in, (T), 25:59475
  interactions $\pi^+ + p \to \Delta^{++} + \text{eta}^0$ at 5 GeV/c, cross sections and spin-density matrix elements for, 25:59297
  interactions $\pi^+ + p \to \Delta^{++} + \pi^0$ at 5 GeV/c, cross sections and spin-density matrix elements for, 25:59297
  interactions $\pi^+ + p \to \Delta^{++} + \pi^+ + \pi^-$ at 8 GeV/c, S-wave resonance effects in $\pi + \pi$ interactions from, (E/T), 25:59296
  interactions $\pi^+ + p \to p + \pi^+$ at 5 GeV/c, cross sections and spin-density matrix elements for, (E), 25:59297
  interactions $\pi^+ + p \to p + \text{rho}^+$ at 5 GeV/c, cross sections and spin-density matrix elements for, (E), 25:59297
  interactions $\pi^+ + p \to \pi^- +$ anything at 18.5 GeV/c in bubble chamber, cross sections for, (E), 25:59319
  interactions $\pi^+ + p \to \pi^+ + p + \omega$ at 3.7 GeV/c, charge asymmetry on $\omega \to \pi^+ + \pi^- + \pi^0$ Dalitz plot from, (E), 25:59308
  interactions $\pi^+ + p \to \pi^+ + p$ at 3.0 to 5.0 GeV/c and 55 to 130°, scintillation counter and spark chamber study of angular distributions for, (E), 25:59285
  interactions $\pi^+ + p \to \text{rho}^0 + \Delta^{++}$ at 11.7 GeV/c, Regge-pole analysis of, (E/T), 25:59499
  interactions $\pi^+ + p \to \text{rho}^0 + \Delta^{++}$ at 11.7 GeV/c, total and differential cross sections for, (E/T), 25:59315
  interactions $\pi^+ + p \to \Sigma^+ + K^+$ at 1.28 and 1.41 GeV/c, test of charge independence in, (E/T), 25:59311
  interactions $\pi^+ + p$ at 1.28 to 1.84 GeV/c, total and differential cross sections for elastic, (E), 25:59309
  interactions $\pi^+ + p$ at 3.6 GeV/c in hydrogen bubble chamber, differential cross sections for elastic, (E), 25:59292
  interactions $\pi^+ + p$ at 8 GeV/c, spin analysis of g-meson from, 25:59298
  interactions $\pi^+ + p$ at 8.5 GeV/c, particle momentum distributions for two-, four-, six-, and eight-prong, (E), 25:59317
  production in $\gamma + p \to \pi^+ + n$ interactions, pseudomodel predictions for differential cross sections for, 25:59362
  production in γ reactions with aluminum, carbon, copper, and lead at 560 MeV, emulsion study of dependence on atomic weight for, (E), 25:59248
  production in $p + p$ interactions at 14.25 to 70 GeV/c, phenomenological study of inclusive single-particle spectra in triple Regge limit for, (T), 25:59505 (JINR-E2-6031)
  reactions $(\pi^+,2p)$ with lithium-6, nitrogen-14, and oxygen-16 at 70 MeV, excitation spectra for, (E), 25:59709 (LA-DC-12389)
  reactions (π^+,p) with beryllium-9, carbon-12, and oxygen-16 at 70 MeV, excitation energy spectra and upper limits for cross sections for, (E), 25:59710 (LA-DC-12781)
  reactions (π^+,π^0) with carbon-13 at 180 MeV, Glauber approximation for differential cross sections for, 25:59523
  scattering by helium-4, contribution of multiple scattering to total cross section for, 25:59524
MESONS (rho)
  bootstrap from current algebra amplitudes for $\pi + \pi$ interactions, 25:59469
  coupling to photons, Veneziano-type representations for, (T), 25:59352
  decay of interfering rho--epsilon, statistical tensors for angular distributions in, 25:59461
  decay $\text{rho}^0 \to \pi^+ + \pi^-$, interference of $\omega \to 2\pi$ with, 25:59552
  interactions rho + N from photoproduction of e^+--e^- pairs at 4 GeV, real forward scattering amplitude for, (E), 25:59252
  interference with $\omega \to \pi^+ + \pi^- + \pi^0$ decay, search for C violation from, 25:59552
  interference with ω in photoproduction processes, phase of rho propagator for, 25:59348
  mass and width in five- and six-charged-particle final states in $\pi^+ + d$ interactions at 2.7 and 3.1 GeV/c in bubble chamber, (E), 25:59282
  mixing of rho--ω in photon reactions (γ,e^+e^-) with nuclei, vector dominance model for, 25:59364
  photoproduction on carbon-12 at 4 GeV, relative rho--ω phase in, (E), 25:59252
  production in anti $p + n \to \pi^+ + 2\pi^- + \pi^0$ interactions at 5.5 GeV/c in deuterium bubble chamber, rate for single and upper limit for double, (E), 25:59276
  production in anti $p + p \to 2\pi^+ + 2\pi^-$ interactions at 2.5 GeV/c, (E), 25:59271
  production in five- and six-charged-particle final states in $\pi^+ + d$ interactions at 2.7 and 3.1 GeV/c in bubble chamber, (E), 25:59282
  production in photon interactions with hadrons, parity rule and helicity conservation in, 25:59384
  production of rho^0 in $\pi^- + p \to \text{rho}^0 + n$ and $\pi^+ + n \to \text{rho}^0 + p$ interactions at 7 GeV/c in bubble chamber, differential cross sections for, (E), 25:59286
  production of rho$^-$ and rho^0 in $\pi^- + p$ two-prong interactions at 3.25 GeV/c in hydrogen bubble chamber, cross sections for peripheral, (E), 25:59314
  production of rho$^-$ in $\pi^- + p \to p + MM^-$ interactions at 3.25 GeV/c with high momentum transfer, differential cross sections for, (E), 25:59312
MESONS (X^0)
  decay $X^0 \to 2\gamma$, hard-meson current algebra and PCAC model for width of, 25:59443
  decay $X^0 \to \gamma + \gamma$ from production in $e^+ + e^-$ interactions, proposed experimental study of, 25:59253
  decay $X^0 \to \gamma + \gamma$ from production in $\pi^- + p$ interactions at 1.6 GeV/c, branching ratio for, (E), 25:59290
  decay $X^0 \to \text{rho}^0 + \gamma$, hard meson current algebra and PCAC model for width of, 25:59443
  mixing of eta and X^0 for cross sections of $e^+ + e^- \to \text{eta}(X^0) + \gamma$ interactions in vector meson region, linear

and quadratic, (T), 25:59377

- production in $e^+ + e^- \to e^+ + e^- + X^0$, $X^0 \to \gamma + \gamma$ interactions, cross sections for, 25:59389
- production in $e^+ + e^- \to X^0 + \gamma$ interactions in vector meson region, vector dominance model with linear and quadratic mixing of eta and X^0 for cross sections of, (T), 25:59377

MESONS, RESONANCE

- bootstrap of sigma from current algebra amplitudes for $\pi + \pi$ interactions, 25:59469
- decay $A_2 \to 3\pi$ in deuterium bubble chamber, (E), 25:59280
- decay $A_2^- \to$ eta $+ \pi^-$ in bubble chamber, A_2^- spin and parity and production mechanism in $\pi^- + p \to A_2^- + p$ interactions at 3.9 and 16 GeV/c in bubble chamber from, (E), 25:59279
- decay delta(966) $\to$ eta $+ \pi$, chiral invariant Lagrangian with massive gauge fields for, 25:59449
- decay eta(1060) $\to 2\pi$, chiral invariant Lagrangian with massive gauge fields for, 25:59449
- decay K(1160) $\to K + \pi$, chiral invariant Lagrangian with massive gauge fields for, 25:59449
- decay of A_1, helicity properties of, 25:59551
- decay of B, helicity properties of, 25:59551
- decay of interfering A_2--background, statistical tensors for angular distributions in, 25:59461
- decay of interfering, statistical tensors for angular distributions in, 25:59461
- decay of K(1760), angular distributions and cross sections for, (E), 25:59318
- decay sigma(730) $\to 2\pi$, chiral invariant Lagrangian with massive gauge fields for, 25:59449
- existence of quasinuclear 2N2antiN, potential approach for, (T), 25:59500
- interactions $A + \pi \to A + \pi$, Veneziano amplitude for, (T), 25:59464
- interference between A_1^+ and A_2^+ in $\pi^+ + p \to 2\pi^+ + \pi^- + p$ interactions at 5 GeV/c, (T), 25:59475
- mass and width in five- and six-charged-particle final states in $\pi^+ + d$ interactions at 2.7 and 3.1 GeV/c in bubble chamber, (E), 25:59282
- mass and width of g(1670), 25:59298
- mass and width of rho (765) in anti $p + p \to$ anti $p + p + \pi^+ + \pi^-$ interactions at 7 GeV/c, (E), 25:59267
- mixing angle for eta and eta' in five- and six-body final states in $\pi^+ + d$ interactions at 2.7 and 3.1 GeV/c in bubble chamber, SU(3), (E), 25:59282
- parity and spin of A_2 from angular distributions for $A_2 \to 3\pi$ decay in deuterium bubble chamber, (E), 25:59280
- parity and spin of A_2^- and daughter from $A_2^- \to$ eta $+ \pi^-$ decay in bubble chamber, (E), 25:59279
- parity and spin of s-wave π rho enhancement in $\pi^+ + p \to 2\pi^+ + \pi^- + p$ interactions at 5 GeV/c, (T), 25:59475
- production and decay of g(1670), 25:59298
- production in five- and six-charged-particle final states in $\pi^+ + d$ interactions at 2.7 and 3.1 GeV/c in bubble chamber, (E), 25:59282
- production of A_2 in Λ and Σ^0 four-body final states in $K^- + n$ interactions at 4.48 GeV/c in deuterium bubble chamber, (E), 25:59280
- production of A_2^- in $\pi^- + p \to A_2^- + p$ interactions at 3.9 and 16 GeV/c in bubble chamber, mechanism for, (E), 25:59279
- production of $g^0(1670)$ in $\pi^+ + d \to p + p + \pi^+ + \pi^-$ and $\pi^- + p \to n + \pi^+ + \pi^-$ interactions at 7 GeV/c, cross sections and spin--parity analysis of, (E), 25:59288
- production of K^* in anti $p + p$ interactions at 2.5 GeV/c, cross sections for, (E), 25:59272
- production of K(1760) in $K^+ + n \to K^+ + \pi^- + p$ and $K^+ + n \to K^0 + \pi^+ + \pi^- + p$ interactions at 9 GeV/c in deuterium bubble chamber, isospin, mass, spin--parity, and widths of, (E), 25:59318
- production of π rho s-wave enhancement in $\pi^+ + p \to 2\pi^+ + \pi^- + p$ interactions at 5 GeV/c, (T), 25:59475
- production of $\pi^+2\pi^-$ system in π^- reactions with light nuclei at 4 GeV/c in freon bubble chamber, cross sections and mass distributions for coherent, (E), 25:59316
- production of rho (765) in anti $p + p \to$ anti $p + p + \pi^+ + \pi^-$ interactions at 7 GeV/c, (E), 25:59267
- production of $S^*(1070)$ in anti $p + p \to 2\pi^+ + 2\pi^-$ interactions at 2.5 GeV/c, (E), 25:59271
- production of S(1727), S(1414), d(1382), and d(1855) in N anti N system from $e^+ + e^-$ colliding-beam interactions, (T), 25:59358
- properties of K(1760), (E), 25:59318
- spin and parity of eta', D, and E in five- and six-charged-particle final states in $\pi^+ + d$ interactions at 2.7 and 3.1 GeV/c in bubble chamber, (E), 25:59282
- spin of g(1670) from production in $\pi + p$ interactions, 25:59298
- theory for, Regge trajectory with finite asymptotic phase in, (T), 25:59451
- width of s-wave π rho enhancement in $\pi^+ + p \to 2\pi^+ + \pi^- + p$ interactions at 5 GeV/c, (T), 25:59475

MESOSPHERE

- development of, from time variations of electron, negative and positive ion densities during sunrise, (E), 25:58859

METAL SPRAYING

- method for preparation of radiation targets, 25:58183 (CONF-711002-, pp 160-5)

METALLIC FOILS

- radiation effects on, design of low-temperature irradiation facility for studies of heavy ion, 25:57620 (RISO-204)

METALLOGRAPHY

- conference on, Cleveland, Ohio, Nov. 16 to 18, 1970, 25:58396

METALLURGICAL EQUIPMENT

- performance of Classimat, for metallographic analysis of molybdenum--thorium oxide spheres, 25:58388 (MLM-OP-71006)

METALS

- corrosion protection of, properties of oxide--phosphate coating for, 25:58375
- determination of trace amounts of, by electrochemical preconcentration and neutron activation, 25:57393
- diffusion of hydrogen through oxide-coated, 25:57298 (ORNL-4676, pp 73-138)
- electron excitation in, (T), 25:59204
- ion reactions with vapors of, review of excited atom formation by charge exchange in, 25:58691
- machining of cylindrical apertures in, by electroerosion, 25:58193
- pressure of flowing liquid, electromagnetic method for measuring, 25:57646(P)
- production of hard, using tungsten carbide, 25:58261
- radioinduced dislocation pile-up in, relations of thermal activation with neutron, 25:58337
- radioinduced void formation in high-purity, review of, 25:58299 (ORNL-TM-3495)
- radioinduced void formation in, conference on, 25:58304
- radioinduced void formation in, relations with dose and temperature, 25:58312
- radioinduced void formation in, review of fast neutron, 25:58305
- radioinduced void formation in, use of ion bombardment to simulate fast neutron, 25:58320
- radioinduced void swelling in, use of high-voltage electron microscope to simulate fast neutron, 25:58326
- thermodynamic properties of liquid, at high temperatures and pressures, equipment for measuring, 25:57635
- void formation and behavior in quenched fcc and hcp, 25:58317

METEORITES

- analysis for selenium by neutron activation, 25:57380
- nitrogen abundance in iron, (E), 25:58423

METEORS

- analysis of iron, for cobalt by neutron activation and γ spectrometry, 25:57386
- antimatter in streams of, annihilation radiation from, (E), 25:58836

METHACRYLIC ACID

- reactions with solvated electrons, rate constant of, 25:57475

METHACRYLIC ACID, METHYL ESTER

- reactions with solvated electrons, rate constant of, 25:57475

METHANE

- deuterium-hydride scattering by, velocity dependence of total effective cross sections for, 25:58782
- deuterium-molecule scattering by, velocity dependence of total effective cross sections for, 25:58782
- helium-atom scattering by, velocity dependence of total effective cross sections for, 25:58782
- iodine-ion reactions at 12 MeV with, electron-capture and -loss cross sections for, (E), 25:58768
- reactions with recoil bromine-80 and bromine-82 from isomeric transition, 25:57491
- yields from γ radiolysis of gaseous ethylene in presence of 2-methylpropene, 25:57474

METHANE, BROMO-

- bromine-80m isomeric transition in, explosion model for fragment distribution from, 25:57501
- radiation effects on, explosion model for fragment distribution from x, 25:57501
- reactions with recoil bromine-80 and bromine-82 from isomeric transition, 25:57492

METHANE, IODO-

- removal by sodium thiosulfate in ice cubes of ice condenser reactor containment systems, (E), 25:60124
- removal from reactor containment, efficiency of activated carbon filters for, (T), 25:60088

METHANESULFONIC ACID, ETHYL ESTER

- effects on yeast, studies on genetic control of mutagenic, 25:57976

METHIONINE

- radioprotective effects against ulceration in rabbit skin, x, 25:58036

METHYLIDYNE

- abundance in delta Scu, (E), 25:58479
- abundance in sunspots, (E/T), 25:58589
- spectra of, frequency of 10 cm radio line in, (E), 25:58700

MICA

- positron emission from positron-bombarded, 25:58681

MICE

- carcinogenicity of 7,12-dimethylbenz [a] anthracene in, effects of deuterium on, 25:57920
- cleft palate and oligodactylia induction in, following in utero exposure to cyclophosphamide, 25:58127
- plutonium-239 distribution in, whole-body autoradiographic method for measurement of, 25:57998

XUM

(NIRS-Pu-8)
  radiation effects on adult, neonatal, and weanling, protective effects of tibial shielding against x, 25:58110
  radiation effects on central nervous system of, review of research on, 25:58143
  radiation effects on growth of transplanted sarcomas in, effects of dose on electron and x, 25:58083
  radiation effects on hematopoiesis in, effects of partial marrow shielding on x, 25:58124
  radiation effects on incidence of cleft palate and oligodactylia in embryos of, in utero exposure x, 25:58127
  radiation effects on intestinal and spleen colony formation and survival of, effects of oxygen on RBE for, 25:57997 (LBL-314)
  radiation effects on relation between total iron-59 uptake and uptake by heme and nonheme fractions of bone marrow and spleen of, x, 25:58119
  radiation effects on sensitivity of lymphoid cells of, to antisera, x, 25:58120
  radiation effects on spleen weight in, effects of dose fractionation on whole-body cobalt-60 γ and x, 25:58108
  radiation effects on survival of, following sublethal hemorrhagic shock, whole-body, 25:58109
  radiation effects on survival of, protective effects of tissue preparations against x, 25:58033
  radiation effects on thymus of, role of bone marrow transplants in recovery from x, 25:58115
  radiation effects on ultrastructure of thymus cells in, x, 25:58114
  radioinduced injuries of intestinal mucosa in, regeneration following gamma and x, 25:58111
  radioinduced lesions in blood, bone marrow, and lungs of, similarity between lesions induced by vaccinal disease and, 25:58128
  radioinduced mutations in germ cells of adult, embryonic, and newborn male, comparison of frequency of x, 25:57967
  redox potential in muscles of, effects of cystamine on, 25:58031
  scintiscanning of blood pool and liver in, effects of pH on distribution of metastable indium-113 during, 25:58043
  ultrastructure of thymus cells in, effects of cortisone and polyoma virus infections on, 25:58114

MICROSOMES
  radiation effects on phospholipase A activity in dog sarcoma, γ, 25:57940

MICROWAVES
  absorption by plasma at upper hybrid frequency, (E), 25:59091
  cosmological implications of cosmic background, (T), 25:58666
  interactions with thermally magnetized plasma, nonlinear harmonic radiations from, (E), 25:59013 (CEA-CONF-1835)
  scattering on plasma, diagnostic use of, 25:58995
  use with interferometers for plasma measurements in JFT-2 device, (E), 25:58979 (JAERI-Memo-4530)

MIDLAND POWER REACTOR, UNIT 1
  effluents from, effects on environment of radioactive and thermal, 25:59978 (DOCKET-50329-27)
  site for, biological data for, 25:59978 (DOCKET-50329-27)

MIDLAND POWER REACTOR, UNIT 2
  effluents from, effects on environment of radioactive and thermal, 25:59978 (DOCKET-50329-27)
  site for, biological data for, 25:59978 (DOCKET-50329-27)

MIDWEST FUEL RECOVERY PLANT
  operation authorization request for, requiring source, special nuclear, and by-product materials, 25:57515 (DOCKET-50268-15)

MIHAMA POWER REACTOR, UNIT 1
  containment structure for, leak rate test for, 25:60000
  emergency power supplies for, design features of, 25:59930
  testing of, performance during power, 25:59927

MILK
  analysis for cesium-137 by radiochemical isolation and γ spectrometry or beta detection, 25:57355
  iodine-131 content of cows', following ingestion of hay contaminated with Plowshare debris, 25:57948 (SWRHL-85-r)
  iodine-131 content of off-site, following Schooner Event, (E), 25:57574 (PNE-524)
  radioisotope content of, in Central, North, and South America during March 1971, 25:57990
  radioisotope content of, in Central, North, and South America during April 1971, barium-140, cesium-137, iodine-131, strontium-89, and strontium-90, 25:57983
  radioisotope content of, in Europe, New Zealand, and USA during 1970, 25:57980(R) (HASL-245)
  strontium-90 content of New York City, during 1970, 25:57981(R) (HASL-245(App.))
  tungsten-187 content of off-site, following Schooner Event, (E), 25:57574 (PNE-524)

MILKY WAY
  cooling processes for interstellar medium, (E/T), 25:58623
  gas motions in disk of, (T), 25:58649
  hydrogen distribution in, ionized, (E/T), 25:58528
  hydrogen distribution in, neutral, (E), 25:58651
  hydrogen in central region of, neutral, (E), 25:58652
  interstellar loop structures in, similarity models of, (T), 25:58640
  loops in, supernova-remnant origin of, (E/T), 25:58628
  magnetic field lines in, stochastic, (T), 25:58657
  map of nucleus of, at 10 μ, (E), 25:58639
  model for, considering far-uv radiation, 25:58638
  model of, density computation for phase--space, (T), 25:58641
  nucleus of, model for, (E/T), 25:58624
  photometry of southern, near-uv surface, (E), 25:58653
  star formation in nucleus of, (E/T), 25:58624
  stars in southern, visual and infrared magnitudes of carbon, (E), 25:58500
  structure in, theory of spiral, 25:58634
  ultraviolet background in, (T), 25:58638
  x-ray background in, spectrum and isotropy of, (E), 25:58650

MILLSTONE POINT POWER REACTOR, UNIT 1
  coolant blowdown in, effects of relief valve failure during pressure transient on, 25:59912 (DOCKET-50245-99)
  emergency core cooling system for, performance evalution of, 25:59943 (DOCKET-50245-95)
  operation of, request for not suspending license for, 25:59944 (DOCKET-50245-98)
  shutdown of, effects on regional power supply of, 25:59956 (DOCKET-50271-63)
  shutdown of, malfunction of turbine pressure control system for pressure transient actuated, 25:59912 (DOCKET-50245-99)
  startup of, 25:59911 (DOCKET-50245-96)
  testing program for, preoperational, 25:59911 (DOCKET-50245-96)
  turbines for, force imbalance corrections for pressure control valve for, 25:59910 (DOCKET-50245-94)

MILLSTONE POINT POWER REACTOR, UNIT 2
  construction of, request for not suspending permit for, 25:59984 (DOCKET-50336-23)
  startup of, effects on regional power supply of delay in, 25:59956 (DOCKET-50271-63)

MISSISSIPPI
  site of Dribble Project in, core and logging data on Hydrologic Test Well 2 at, 25:57563 (USGS-474-111)
  site of Dribble Project in, core and logging data on Hydrologic Test Well 1 at, 25:57562 (USGS-474-110)
  stratigraphy around Tatum dome in Lamar County, effects on seismic wave propagation, 25:57595 (USGS-474-112)
  stratigraphy of southeastern, near Project Dribble site, 25:57596 (USGS-474-129)

MITOCHONDRIA
  radiation effects on aminotransferase activiy in rat tissue, x, 25:57933
  radiation effects on ATP activity in rat liver, radon, 25:57932
  radiation effects on phospholipase A activity in dog sarcoma, γ, 25:57940
  radioinduced degeneration of HeLa cell, electron microscopy of x, 25:58085

MITOSIS
  effects of time of onset of, on fast neutron, γ, and x radiosensitivity of chromosomes in seeds of Crepis capillaris, 25:57968
  radiation effects on cultured human cancer cell, additive effects of colchicine on γ, 25:58080
  radiation effects on rat liver cell, mechanism for x, 25:58130
  radiation effects on, in bone marrow cells of laboratory and wild rats, comparison of x, 25:58116

MIXER-SETTLERS
  development for liquid metal--molten salt systems, 25:57508 (ANL-7810)

MOESSBAUER EFFECT
  research progress on, 25:57442
  temperature shift in, equivalence with gravitational red shift for, (T), 25:59596

MOLECULES
  atom reactions at thermal energies with, cross sections for ionization in excited-, (T), 25:58750
  atom reactions with diatomic, adiabatic-approximation calculations of vibrational transition probabilities in, 25:58761
  atom reactions with diatomic, reaction matrix method for calculation of transition probabilities in, 25:58762
  atom reactions with diatomic, semiclassical treatment of Morse-oscillator systems, 25:58727
  electron reactions with diatomic, selection rule for Σ^+--Σ^- transitions in, 25:58732
  electron reactions with, review of energy resolution in, 25:58747
  electron scattering by, compound states in, (T), 25:58804
  ion reactions with, additive rule for charge-exchange cross sections for, 25:58768
  ion reactions with, Doppler broadening due to thermal motion of molecules in beam experiments on, (T), 25:58752

potentials of diatomic, development of perturbation method to study Morse-like, 25:58372
reactions with atoms and molecules with formation of long-lived complexes, angular distribution of products from, (T), 25:58773
spectral hyperfine effects in, many-body theory for, 25:58794
structure of quark, electronic, 25:59344

MOLTEN SALT BREEDER EXPERIMENT
design of single fluid 1000 MW(e), 25:60015 (ORNL-4676, pp 21-72)
design parameters of, 25:60015 (ORNL-4676, pp 21-72)
fission product removal from fuel salt in, performance of gas separators and bubble generators for, (E), 25:60015 (ORNL-4676, pp 21-72)

MOLTEN SALT BREEDER REACTOR
fuel processing for, development of test stand for, 25:58168 (ORNL-4676, pp 139-233)
fuel reprocessing for, 25:57298 (ORNL-4676, pp 73-138)
fuel reprocessing for, flowsheet analysis for, 25:57522 (ORNL-4676, pp 234-71)
fuel salt for, heat and mass transfer and thermophysical properties of, (E/T), 25:60015 (ORNL-4676, pp 21-72)
heat exchangers for, effects of tubing failures in, (T), 25:60015 (ORNL-4676, pp 21-72)
heat exchangers for, shutdown temperature transients in empty, (T), 25:60015 (ORNL-4676, pp 21-72)
physics analysis of single fluid 1000 MW(e), 25:60015 (ORNL-4676, pp 21-72)
steam generator for, hybrid computer simulation model of, 25:60015 (ORNL-4676, pp 21-72)
tritium distribution and control in, (T), 25:60015 (ORNL-4676, pp 21-72)

MOLTEN SALT REACTOR EXPERIMENT
components for, evaluation of stability of, 25:58168 (ORNL-4676, pp 139-233)
coolant salt flowmeter for, accuracy of differential pressure system on, (E), 25:60096 (ORNL-4676, pp 1-20)
coolant salt for, postoperation inspection of pump for, 25:60015 (ORNL-4676, pp 21-72)
core for, postoperation examination of, 25:60096 (ORNL-4676, pp 1-20)
fission product chemistry in, 25:57298 (ORNL-4676, pp 73-138)
fuel pump bowl in, examination of deposits from mist shield in, 25:57298 (ORNL-4676, pp 73-138)
fuel pumps bowl for, postoperation examination of, 25:60096 (ORNL-4676, pp 1-20)
fuel salt for, postoperation inspection of Mark 2 pump for, 25:60015 (ORNL-4676, pp 21-72)
fuel salt freeze valve for, postoperation inspection of leak in, 25:60096 (ORNL-4676, pp 1-20)
fuel salt processing plant for, residual plutonium and uranium in, 25:60096 (ORNL-4676, pp 1-20)
heat exchanger for, postoperation examination of, 25:60096 (ORNL-4676, pp 1-20)
maintenance of, tools and procedures for remote, 25:60096 (ORNL-4676, pp 1-20)

MOLYBDENUM
analysis for oxygen by 14-MeV neutron activation and γ spectrometry, 25:57376
crystal lattice defects in, effects on proton diffraction patterns, 25:58275
Debye--Waller factor of, temperature dependence of, 25:59179
determination by potentiometric titration using potassium chlorate, 25:57309
determination in fertilizers by atomic absorption spectrophotometry, 25:57306
determination of trace amounts of, by kinetic biamperometric method, 25:57336
determination using salicylhydroxamic acid, gravimetric, 25:57308
diffusion in chromium and titanium films, ion--ion emission studies on, 25:58266
ductility of crystallized wires of, effects of carbon content and grain size on, 25:58269
effects on complexonometric determination of rare earths, 25:57317
effects on hardness of dispersion-hardening iron-base alloys, 25:58235
electric conductivity of laser-evaporated films of, temperature coefficient of, 25:59186
electron reactions at 12.5 to 22 MeV with, bremsstrahlung yield from, 25:59106
fabrication of MSBR fuel processing test stand components of, 25:58168 (ORNL-4676, pp 139-233)
helium-ion reactions at 45 to 90 keV/amu with, helium-isotope dependence of cross sections for L-shell ionization in, (E), 25:58776
machining of cylindrical apertures in, by electroerosion, 25:58193
mechanical properties of single crystals of, effects of carbon and iron-group metals on, 25:58257
mechanical properties of wires of, effects of gas evolution at 1500°C on, 25:58221
photon reactions with, secondary electron emission from, (E/T), 25:59107
preparation by hydrogen reduction of molybdenum trioxide, 25:58189
preparation of radiation targets of, by argon ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
preparation of thick samples of, by powder metallurgy, 25:58181 (CONF-711002-, pp 77-81)
radiation effects on microstructure of, comparison of 2-MeV nitrogen ion and fast neutron, 25:58332
radiation effects on regular void array in high-purity, high-temperature 2-MeV nitrogen ion, 25:58340
radioinduced void formation in, electron microscopic study of fast neutron, 25:58309
radioinduced void formation in, neutron, 25:58300 (ORNL-TM-3496)
slip bands in single crystals of, x-ray topography method for measuring, 25:58271 (CALT-767-P-3-19)
solvent properties for nitrogen at high temperatures, 25:58249
structure of polycrystalline, during extrusion hardening, 25:58277
structure of, effects of deformation temperature on, 25:58231
surface energy and work function of smooth faces of monocrystal of, (T), 25:59194
thermal conductivity at 8 to 2037°C, 25:58344(R) (LA-4693)
thermal cycling stability of, effects of rhenium on, 25:58247
vapor deposition on iron alloys by reduction of molybdenum hexafluoride, 25:58168 (ORNL-4676, pp 139-233)
void lattice structure in, (T), 25:58313
weld defects in, morphology of, 25:58215 (Y-DA-4280)

MOLYBDENUM ALLOYS AND SYSTEMS
mechanical properties of, effects of deformation temperature on, 25:58231
Al--Cr--Mo--W, development of cast, for turbine blades, 25:58203
Al--Mo, structure of drops of, formed at high cooling rates, 25:58284
C--Cr--Fe--Hf--Mn--Mo--Nb--Ni-base--Si--Ti--Zr, radiation effects on mechanical properties of, relations of composition with thermal neutron, 25:58168 (ORNL-4676, pp 139-233)
C--Mo--Ni, phase composition in molybdenum-rich solutions of, at 1200 to 1800°C, 25:58290
C--Mo--Zr, phase studies of, 25:58273
C--Mo-base, crystallization and carbide phase formation in, effects of carbon content on, 25:58282
Co--Fe-base--Mo, hardness of dispersion-hardening hard facing, effects of primary and secondary additions on, 25:58235
Co--Fe-base--Mo--Ni, aging of, dilatometric, electric conductivity, and electron microscopy studies on, 25:58232
Co-base--Fe--Mo--Ti, magnetic properties of wires of, 25:59197
Fe-base--Mo--Ni, aging of, dilatometric, electric conductivity, and electron microscopy studies on, 25:58232
Mo--Nb, composition of electronic-melted zone liquation-produced, 25:58260
Mo--Nb, solvent properties for nitrogen at high temperatures, 25:58249
Mo--Nb-base, creep at 1100 to 1300°C, effects of molybdenum content on steady, 25:58222
Mo--Nb-base--Zr, machining characteristics of, at high and low temperatures, 25:58198
Mo--Ni, hardness and structure of electrodeposited, 25:58256
Mo--PuO_2, aging experiments on curium oxide-doped cermet pellets of, flowsheets for, 25:57658(R) (ORNL-4723)
Mo--PuO_2--ThO_2, etching of sintered, for optical microcopy, method for, 25:58354
Mo--Sn--Ti-base--Zr, tensile properties of Beta III, at room temperature, 25:58234
Mo--ThO_2, metallographic properties of cermet spheres of, 25:58388 (MLM-OP-71006)
Mo--ThO_2, preparation of cermets of, development of cold- and hot-press sintering methods for, 25:57658(R) (ORNL-4723)
Mo--Ti, thermodynamic properties at 1844 and 1900°K, triple Knudsen-cell measurements of, 25:58265
Mo--UO_2-base, preparation of dense homogeneous, method for, 25:58348 (LFEN-NI.-53-a)
Mo--W, solvent properties for nitrogen at high temperatures, 25:58249
Mo-base--Nb, thermal cycling of monocrystals of, dimensional effects of, 25:58247
Mo-base--Ti, radioinduced void formation in, neutron, 25:58300 (ORNL-TM-3496)
Mo-base--W, mechanical properties and recrystallization temperature of, effects of tungsten content on, 25:58248
Mo-base--W--Zr, mechanical properties and recrystallization temperature of, effects of tungsten and zirconium contents on, 25:58248

MOLYBDENUM FLUORIDES
reactions in molten lithium beryllium fluoride solutions, kinetics of, 25:57298 (ORNL-4676, pp 73-138)

MOLYBDENUM ISOTOPES Mo-92
nuclear charge distribution from electron elastic scattering, (E), 25:59791

MOLYBDENUM ISOTOPES Mo-99
separation of technetium-99m from, by solvent extraction

XUM

  and ion exchange, 25:57483

MOLYBDENUM OXIDES
  performance as lubricant for deep drawing of nickel alloys and stainless steel, 25:58195
  redox potential of molten MoO_3 at 850°C, effects of oxygen pressure on, 25:58374
  reduction to metal using hydrogen, effects of water vapor on, 25:58189

MONAZITES
  analysis for uranium by solvent extraction and polarography, 25:57334

MONTICELLO POWER REACTOR, UNIT 1
  emergency core cooling system for, startup problems with high pressure injection, 25:59913 (DOCKET-50263-88)
  operation of, request for not suspending license for, 25:59953 (DOCKET-50263-87)
  radioactive waste disposal system, revised and additional data on gaseous, 25:59952 (DOCKET-50263-86)

MOON
  atmosphere of, distribution, escape, source, and contamination of gaseous, 25:58679
  composition and physical characteristics of, review of Apollo 11, 12, and 14 and Luna 16 data of, 25:58677
  radon-222 distribution on surface of, uniform and pile-up, (E/T), 25:58680
  volcanism on, evidence for, (E), 25:58678

MUCOSA
  radioinduced injuries of mouse intestinal, regeneration following gamma and x, 25:58111

MUSCLES
  redox potential in dog, mouse, and rat, effects of cystamine on, 25:58031

MUTATIONS
  localization of x-radioinduced suppressor, in Drosophila chromosomes, 25:57975
  radiation effects on frequency of somatic recombinations in tobacco chlorophyll, γ, 25:57977
  radioinduced, in bacteriophage phi X174, effects of oxygen, nitrogen, and thiourea on gamma and x, 25:57971
  radioinduced, in Drosophila, antagonistic effects of vibrations on gamma, 25:57953
  radioinduced, in Escherichia coli, effects of 5-bromouracil substitution of DNA on frequency of uv, 25:57965
  radioinduced, in germ cells of adult, embryonic, and newborn male mice, comparison of frequency of x, 25:57967
  radioinduced, in Neurospora, effects of diepoxybutane on uv, 25:57954
  radioinduced, in peas following seed exposure, comparison of neutron and x, 25:57960
  radioinduced, in spores of Actinomyces hygroscopicus, effects of hygromycin B and streptomycin on frequency of x, 25:57964
  radioinduced, in xiphophorin fish for macromelanophores, synergistic effects of hybridization on x, 25:57957
  radioinduced, in yeast, studies on genetic control of uv and x, 25:57976

MUTSU REACTOR
  design parameters of, 25:60205
  operation of, effectiveness of air conditioning system for filtering airborne radioactivity during, 25:60205

N

NAPHTHALENE
  effects on γ-radioinduced polymerization of styrene in carbon tetrachloride or hexachlorobutadiene solutions, 25:57454

NATIONAL ACCELERATOR LABORATORY SYNCHROTRON
  beam injection booster synchrotron for, computer-based instrumentation and control system using CAMAC for 8-GeV, 25:59664
  beam injector booster synchrotron for, CAMAC control system for, 25:59655

NATIONAL REACTOR TESTING STATION
  protection systems at, fault tree analysis and reliability methods for performance of, 25:60187

NATURAL GAS
  decontamination of nuclear explosion-produced, method for underground storage for, 25:57605(P)

NBS RESEARCH REACTOR
  heat exchanger for, replacement of primary system, 25:60151 (DOCKET-50184-33)
  operations during January to June 1971, 25:60150 (DOCKET-50184-32)

NEBULAE
  chlorine abundance in Orion, (E), 25:58593
  distance to NGC 1579, (E), 25:58504
  electron densities in Orion A and M17, (E), 25:58546
  gamma-ray production in, surrounding pulsar, (T), 25:58550
  helium abundance in Orion, (E/T), 25:58446
  radiative transfer problems in gaseous, line and continuum, (T), 25:58473
  radio recombination lines in Orion A and M17, Stark broadening of, (E), 25:58546
  spectra of gaseous, level populations of hydrogenic ions in, (E/T), 25:58516
  spectra of Orion, emission, (E), 25:58513
  survey of planetary, at 9.3, 4.5, and 2.8 cm, (E), 25:58544

NEMATODA
  Ascaridia galli, use of γ irradiated eggs of, for immunization of chickens, 25:57946

NEODYMIUM
  abundance on surfaces of peculiar A stars, (E/T), 25:58462
  complexes with HEDTA, dissociation constants for, 25:57537
  desorption from tungsten filaments using electric field, 25:58230
  determination in pyrolytic graphite by neutron activation and counting of delayed β and γ coincidences, 25:57389
  determination in silicate rocks by neutron activation, low-energy photon detector for, 25:57387
  energy levels of, from analysis of spectra between 2450 and 40500 A, 25:58705
  oxidation potential for trivalent--tetravalent, 25:57437
  separation from europium and samarium in chloride solution by solvent extraction using DEHPA in heptane, factors for, 25:57543
  separation from fission products by electromigration following complexing with nitrilotriacetic acid, 25:57558
  solubility in chromium at 1000 to 1800°C, metallographic, microhardness, and x-ray diffraction measurements on, 25:58237
  solubility in lithium--bismuth solutions, 25:57522 (ORNL-4676, pp 234-71)

NEODYMIUM IONS
  energy level calculations for Nd IV, using Hartree--Fock method, 25:58709
  energy levels of Nd II, from analysis of spectra between 2450 and 42500 A, 25:58705

NEODYMIUM ISOTOPES Nd-142
  electron scattering at 129.4, 199.3, 299.1, and 499.5 MeV, differential cross sections for, (E), 25:59793
  energy-level scheme from samarium-142 decay, 25:59821
  nuclear charge distribution from electron differential scattering cross sections at 129.4, 199.3, 299.1, and 499.5 MeV and least squares analysis, (E/T), 25:59793

NEON
  electric discharges in alkali-metal-seeded, properties of high-current, 25:59023
  electron reactions with, model potentials for, 25:58772
  ion reactions in keV range with, effects of velocity and outer-shell configuration on K-vacancy production in, (E), 25:58756
  ionization in lunar atmosphere and associated properties, 25:58679
  plasma jets of, interferometric determination of temperature in, (E), 25:58984
  plasma jets of, spectroscopic diagnostics of, 25:58991
  plasma of, in pseudo equilibrium with additions, interactions of, 25:59018
  plasma of, metastable densities in neutron environment, (E/T), 25:59003
  positron annihilation in, time dependence of, (E), 25:58725

NEON IONS
  effects on benzene vapor at 60 keV, yields from, 25:57469
  effects on germanium monocrystals at 10 to 30 keV, electron emission induced by, 25:59175
  emission spectra of, in solar corona, (E), 25:58621
  reactions with germanium crystals at 10 to 30 keV, angular dependence of, (E/T), 25:59146
  reactions with neon and nitrogen molecules in keV range, production of K vacancies in, (E), 25:58756
  x-ray spectra of solar, (E), 25:58583

NEON ISOTOPES Ne-19
  energy levels at 1.508 and 1.536 MeV from fluorine-19 (p,n) and oxygen-16 (α,n) reactions, lifetimes of, (E), 25:59719

NEON ISOTOPES Ne-20
  deuteron reactions (d,He-3) with, coupled-channel analysis for inelastic effects in, (T), 25:59758
  electron reactions with, production of meson (π) in bound state from, 25:59355
  energy levels from carbon-12 (C-12,α) reactions, evidence for quartet, (E), 25:59717
  energy levels from carbon-12 (N-14,Li-6) reactions, structure of upper $K = 0^+$, (E), 25:59743
  energy levels from electron inelastic scattering, model analysis of, (E/T), 25:59736
  energy levels of, calculation for α-hole, 25:59757
  production in stars from simple helium burning, (E), 25:58508

NEON ISOTOPES Ne-24
  energy levels of, description using mixed oblate and prolate Hartree-Fock solutions, (T), 25:59728

NEON SYSTEMS
  He--Ne, atomic metastable densities in neutron environment, (E/T), 25:59003
  N--Ne, plasma decay in mixtures of, ion production and loss in, (E), 25:59019

NEPTUNIUM
  deposition as oxide on instrument parts of stainless steel, electrolytic, 25:57440
  oxidation of hexavalent, by potassium persulfate,

  kinetics of, 25:57412
  oxidation potential for trivalent--tetravalent, 25:57437
  preparation and properties of heptavalent, 25:57404
  preparation of radiation targets of, methods for, 25:59634 (CONF-711002-, pp 59-69)
  preparation of thick samples of, by powder metallurgy, 25:58181 (CONF-711002-, pp 77-81)
  preparation of thin films of, by electrophoresis and electrospraying, 25:58183 (CONF-711002-, pp 160-5)
  reactions of hexavalent and pentavalent, with hydrogen peroxide in nitric acid, 25:57414
  separation from aqueous solutions by solvent extraction using TTA, 25:57535
  separation from other actinides by paper or thin-layer chromatography, 25:57553
  separation from plutonium and promethium by ion exchange chromatography on zirconium phosphate, 25:57550
  separation of various valence forms of, by paper or thin-layer chromatography, 25:57553
  spectra of hexavalent, in dilute sodium carbonate solutions, absorption, 25:57403
NEPTUNIUM ISOTOPES
  cross section measurements of, nondestructive and destructive methods of analysis used in fabrication of targets for, 25:57345 (CONF-711002-, pp 293-306)
NEPTUNIUM OXIDES
  preparation of targets of, by vacuum evaporation, 25:59638 (CONF-711002-, pp 116-21)
NEPTUNIUM SULFATES
  complexes with cobalthexaammine ion, preparation and structure of, 25:57403
NERVES
  radiation effects on electrophysiological activity of, sensitizing effects of dyes on uv, 25:57942
  radiation effects on membranes of isolated fibers of crab, studies on role of nucleotides in excitability characteristics using uv, 25:57939
NERVOUS SYSTEM
  radiation effects on central, review of research on, 25:58143
  radiation injuries to rat, effects of focal distance on x, 25:58098
NETHERLANDS
  radioactivity monitoring of airborne dusts over, 1967, 25:57575 (RA-42)
NEUTRINOS
  emission from hot dense stars, URCA process in, (T), 25:58492
  fields in presence of gravitational field, positive energy density for, 25:59589
  interactions and properties of, (T), 25:59403
  interactions $\nu + N \to l +$ meson + baryon, urbaryon model of hadrons for, 25:59394
  interactions $\nu + n \to \mu^- + p$ in Veneziano model, $(\mu + n)$ resonance in, 25:59395
  production in annihilation of polarized leptons, (T), 25:59402
  reactions $(\nu,\mu^- W^+)$ with nuclei at high energies, angular and energy distributions for W production in, 25:59410
  reactions with nuclei, Coulomb corrections to Adler PCAC test in inelastic, 25:59406
  scattering by aluminum-27 and iron-56, weak nucleon processes for impulse approximation for quasielastic forward, (T), 25:59397
  theory for, weak leptonic and semileptonic processes for two- and four-component, (T), 25:59407
NEUTRINOS (ν/sub μ/)
  interactions $\nu + N \to \mu^- +$ meson + baryon, urbaryon model of hadrons for, 25:59394
  interactions $\nu + N \to \mu^- + W^+ + N$, μ^- angular and momentum distributions for, (T), 25:59414
  interactions $\nu + N$ at high energies, μ spectra from, (T), 25:59417
  mass from μ polarization in $\pi^- \to \mu^- +$ anti ν decay, 25:59257
  reactions with iron, angular and momentum distributions of μ^+ and e^+ in direct production of lepton pairs in, (T), 25:59415
  reactions with iron, μ^- angular and momentum distributions for μ^- and W^+ production in, (T), 25:59414
  reactions with nuclei, angular and momentum distributions of μ^+ and e^+ in direct production of lepton pairs in, (T), 25:59415
NEUTRINOS (anti ν/sub μ/)
  interactions anti $\nu + N \to \mu^+ +$ meson + baryon, urbaryon model of hadrons for, 25:59394
NEUTRON BEAMS
  production of fast, from radioisotope sources, 25:59690
NEUTRON CROSS SECTIONS
  data libraries for group-averaged discrete-ordinate, computer programs for, 25:59843 (SC-DR-710320)
  evaluation of data sets and codes for fast reactor analysis, 25:60210 (JAERI-Memo-4406)
  library for, description of LRL evaluated, (E), 25:59783 (UCRL-50400(Vol.4))
NEUTRON SOURCES
  correlation techniques for use at pulsed reactor, time-of-flight, 25:59672 (KFKI-71-45)
  description of 14-MeV T(d,n), 25:59676
  description of californium-252, 25:57661
  neutron beam production from radioisotope, method for, 25:59690
  preparation of curium-242--beryllium and plutonium-238--beryllium, 25:59669 (CEA-R-4172)
  source strength calibration using reactor kinetics method, 25:59688
  spectra and dose-fluence conversion factors for standard radioisotope, 25:57676
  targets for high-yield T(d,n), fabrication of tritium, 25:59670 (CONF-711002-, pp 166-80)
  use in method for measuring fluid flow, 25:57667(P)
NEUTRON SPECTROMETERS
  performance of helium-3 solid state, for time-and energy-dependent spectra measurements, (E), 25:60156(R) (GULF-RT-A-10800)
NEUTRON STARS
  densities in, (T), 25:58564
  density of matter in, (T), 25:58432
  equation of state for, derivation using realistic interactions, (T), 25:59866
  low-temperature phenomena in, (T), 25:58520
  luminosity of, (T), 25:58433
  mass ejection from, in binary systems, (T), 25:58424
  mass limit for, (T), 25:58432
  mass of, limits of, (T), 25:58564
  models for, densities and masses in, 25:58493
  radio emission from expanding charge sheets associated with, (T), 25:58549
  relation to GX 340 + 0, (E), 25:58534
  solid states in interiors of, physics of, (T), 25:58448
  structure of, (T), 25:58520
  thermodynamics of totally degenerate, (T), 25:58521
NEUTRONS
  capture by deuterium and helium-3, cross sections for $n + p \to d + 2\gamma$ interactions at 0.025 eV for cross sections for two-quantum radiative, (T), 25:59527
  capture by hydrogen at 0.025 eV, cross sections and photon angular and spectral distributions for two-quantum radiative, (T), 25:59527
  capture by uranium-238 in uranium and uranyl acetates and sulfates, chemical states of recoil uranium-239 from, 25:57488
  capture by Z = 49 to 92 nuclei at 30 keV to 1.4 MeV, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801
  capture on surfaces of peculiar A stars, r-process elements from, (E/T), 25:58462
  collision probabilities in cluster-type fuel lattices, (T), 25:60231
  decay $n \to p + e + \nu$, field-theoretical basis for weak-interaction theory for, (T), 25:59397
  detection and measurement of, self-powered detectors for, 25:57777
  detection of, design criteria for radiation resistant silicon detectors for, 25:57746
  detection of, self-powered detector for, 25:57728(P)
  diffusion calculations for reactors, self-initializing version of WIGL2 code for, 25:60209 (DUN-7538)
  diffusion constants for aluminum--hydrogen lattice, (T), 25:59687
  distribution in clusters of rod type fuel element assemblies, calculation of first flight collision probabilities for, (T), 25:60235
  distribution in thin homogeneous natural uranium slabs, synthesis solution of multigroup Boltzmann equation for, 25:60214
  dose rates in two-layered slab shields, semi-empirical representation of, 25:59117
  dose to man following accidental exposure, effectiveness of activation and biological detectors for measuring, 25:58019
  dosimetry behind shielding, response of various dosimeters for, 25:57858
  dosimetry of mixed gamma and, thermoluminescent dosimeter for, 25:57849
  dosimetry of, characteristics of polyethylene-moderated proportional detectors for, 25:57782
  dosimetry of, development of fission foil--dielectric track detector for, 25:57856
  dosimetry of, development of thermoluminescent and exoelectron dosimeters for personnel, 25:57833
  dosimetry of, multiple activation detector for accident, 25:57857
  dosimetry of, performance of fission foil--dielectric track detectors for personnel, 25:57855
  dosimetry of, performance of Fricke dosimeter for, 25:57862
  dosimetry of, self-powered detector for, 25:57776
  dosimetry of, uranium foil--dielectric track detector for personnel, 25:57854
  effects on anelastic properties of aluminum, effects of cold-working and annealing on, 25:58338
  effects on catalytic activity of palladium in hydrogenation of butynediol, 25:57448
  effects on chromium trisacetylacetone or chromium-51-doped chromium trisacetylacetone, 25:57496
  effects on chromosomes of medical personnel, effects of dose and dose fractionation on aberrant, 25:57972
  effects on deformation in titanium--vanadium alloys at low temperature, 25:58339
  effects on dimensions of graphite specimens, 25:58366 (CEA-CONF-1820)

XUM

- effects on dislocation pile-up in metals, relations with thermal activation, 25:58337
- effects on frequency vs temperature characteristics of synthetic-quartz AT resonators, 25:57906
- effects on graphite, specific heat--magnetic field study of, 25:59148
- effects on helium release from boron-doped nickel, 25:58335
- effects on high-temperature mechanical properties of aluminum--chromium--nickel-base--titanium alloys, 25:58295 (FRNC-TH-64)
- effects on incidence of mutations in peas following seed exposure, comparison between x-ray effects and, 25:57960
- effects on magnetic thin-film recording systems, 25:57908
- effects on mammalian cells, review of effects of LET on repair of, 25:58089
- effects on mechanical properties of Hastelloy N, relations with hafnium, niobium, and titanium additions, 25:58168 (ORNL-4676, pp 139-233)
- effects on mechanical properties of mono- and polycrystals of rhenium, 25:58342
- effects on microstructure and void formation in refractory metals and alloys, 25:58300 (ORNL-TM-3496)
- effects on nil-ductility transition temperature of reactor pressure vessels, surveillance program on, 25:58294 (BAW-10006(Rev.2))
- effects on polymerization of benzene or toluene in presence of aluminum nitride, 25:57456
- effects on potassium trisoxalato chromate, reactions of recoil chromium-51 from, 25:57490
- effects on silica and germania, ESR studies of defects induced in, 25:59174
- effects on silicon, review of defects produced in, 25:59135
- effects on tripolyphosphate hexahydrate, effects of radical scavengers on yields from, 25:57495
- effects on trisoxinatocobalt, reactions of recoil cobalt-60 from, 25:57493
- effects on void distribution in aluminum, relations with dislocations and impurities, 25:58298 (ORNL-TM-3493)
- effects on void formation in nickel, relations with subsequent electron irradiation, 25:58333
- emission rate from plutonium dioxide, effects of oxygen-17 and -18 contents on, 25:57655 (MLM-1844)
- energy in reactors, effects on noise spectra of, (E/T), 25:60238
- fluence measurements of, cadmium sulfide and cadmium selenide detectors for, 25:57758(P)
- flux in cells of finite square reactor lattices, source-sink theory analysis of, 25:60228
- flux measurements of, preparation of Al_2O_3--CoO and MgO--CoO for high-temperature, 25:57723 (CONF-711002-, pp 82-5)
- flux monitoring, preparation of activation detectors for in-core, 25:57724 (CONF-711002-, pp 86-90)
- interactions anti $n + n$, total cross sections, (E), 25:59275
- interactions anti $p + n \to 2\pi^- + \pi^+$ at rest, five-point function in dual model for, (T), 25:59465
- interactions anti $p + n \to \pi^+ + 2\pi^- + \pi^0$ at 5.5 GeV/c in deuterium bubble chamber, cross sections and rate for single rho production and upper limit for double rho production in, (E), 25:59276
- interactions $d + n \to (nn) + p$ at 2 to 160 MeV, three-body separable potential for, 25:59510
- interactions $\gamma + n \to \gamma + n$, quark model extension for total and differential cross sections for, (T), 25:59378
- interactions $\gamma + n \to \pi^0 + n$ at 4 GeV, cross sections relative to $\gamma + p \to \pi^0 + p$ interactions, (E), 25:59243
- interactions $\gamma + n \to$ rho$^-$ $+ p$, rho-exchange contribution to differential cross sections for, 25:59385
- interactions $K^+ + n \to K^+ + \pi^- + p$ and $K^+ + n \to K^0 + \pi^+ + \pi^- + p$ at 9 GeV/c in deuterium bubble chamber, cross sections and mass spectra from, (E), 25:59318
- interactions $K^+ + n \to K^+ + \pi^- + p$ at 3 GeV/c, unitarized Veneziano model for, 25:59478
- interactions $K^- + n \to \pi^- + \Lambda$ and $\pi^+ + n \to K^+ + \Lambda$, duality and exchange degeneracy from finite-energy sum rules for, 25:59501
- interactions $K^- + n$ at 3 GeV/c, differential cross sections for two-body, (E), 25:59291
- interactions $K^- + n$ at 4.48 GeV/c in deuterium bubble chamber, $\Sigma(1640)$ and A_2 production, and simultaneous production of vector mesons and $\Sigma^-(1385)$ in Λ and Σ^0 four-body final states in, (E), 25:59280
- interactions $K^- + n$ at 810 to 1110 MeV, angular distributions for elastic, (E), 25:59302
- interactions $n + d$, calculation of doublet scattering length using rank-four separable potential, (T), 25:59707
- interactions $n + n$ at rest, triton reactions (t,nHe-4) with tritium for determination of scattering length for, (E), 25:59506 (JINR-E15-5905)
- interactions $n + n$, effect of charge asymmetric potentials on scattering length for, (T), 25:59701
- interactions $n + p \to d + 2\gamma$ at 0.025 eV, cross sections and photon angular and spectral distributions for, (T), 25:59527
- interactions $n + p \to d + \gamma$, relation of effective Lagrangian for nonleptonic weak interactions with Lagrangian for, (T), 25:59418
- interactions $n + p \to \pi^0 + d$ from threshold to 720 MeV, test of isospin invariance in, (E/T), 25:59268
- interactions $n + p$ at low energies, scattering amplitudes for, (E), 25:59696
- interactions $\nu + n \to \mu^- + p$ in Veneziano model, $(\mu + n)$ resonance in, 25:59395
- interactions $\pi^+ + n \to K^+ + \Lambda$ and $K^- + n \to \pi^- + \Lambda$, duality and exchange degeneracy from finite-energy sum rules, 25:59501
- interactions $\pi^+ + n \to$ rho^0 $+ p$ at 7 GeV/c in bubble chamber, angular distributions from, (E), 25:59286
- noise detection methods for boiling in reactors, development of, 25:60181
- pairing in lead, nickel, and tin isotopes, equilibrium, (T), 25:59833 (JINR-E4-5907)
- production of low-energy, in μ capture by calcium and sulfur, asymmetry coefficient for angular distribution for, (E), 25:59738 (JINR-P1-6029)
- production over losses ratio for integral reactor characteristic, derivation of, 25:60227
- reactions (n,f) with plutonium-239, uranium-233, and uranium-235 at thermal to 2 MeV energies, energy dependence of prompt neutron yields from, (E), 25:59810
- reactions (n,γ) with nickel in cladding materials, helium production by, 25:58336
- reactions with fissile nuclei, effect of level interference on cross sections for slow, (T), 25:59879
- reactions with plutonium-239 up to 15 keV, review of data on capture-to-fission ratio for, 25:59812
- reactions with thorium-230 and thorium-232, production of protactinium-231 and uranium-232 by, 25:57479 (BMBW-FBK-71-6)
- scattering and transport in condensed matter, (T), 25:59673 (LFEN-NI.-51-a)
- scattering by deuterium, dispersion relations for unphysical cuts in nuclear structure studies of elastic, (T), 25:59691 (LA-DC-12958)
- scattering by heavy water, computer program for double differential cross sections, scattering matrix, and integrated cross sections for, (T), 25:59671 (IFA-DNBR-3)
- scattering by spherical optical potential, computer program for calculating elastic and inelastic, (T), 25:59842 (RT/FI-(71)6)
- scattering by uranium-235, multilevel analysis of cross section data for, (T), 25:59828 (COO-2022-10)
- scattering by water at 0.04 to 0.632 eV at 27 to 270 C, differential cross sections for inelastic, (E/T), 25:59685
- scattering in magnetized crystals, diffraction polarization in, (T), 25:59681
- scattering of pulsed, from hydrogeous compounds, 25:58384
- slowing down times in moderators, effects neutron pulse shapes on, (T), 25:60232
- spectra in beam port of Cornell University TRIGA, preparation and measurement of tailored, (E), 25:60163
- spectra in fast reactors, model for analytic representation of flux and importance, 25:60211 (RPI-328-189)
- spectra in fast reactors, synthesis of 50 energy-group, 25:60215
- spectra measurements of, computer program for unfolding data from activation detectors for, 25:57725 (KFKI-71-22)
- transport equation for, fundamental eigenvalues of linear, 25:59683
- transport equation, method for combining lower- and higher-order discrete-ordinate approximation, 25:59680
- transport equations, variational variable boundary functionals for approximation methods for, 25:59677
- transport of, discrete SN numerical method for solving Boltzmann equation for, (T), 25:59675
- transport problems, numerical methods for, 25:59684
- transport theory, some analytical methods in, 25:59682
- wave propagation in bounded plane geometry, 25:59679

NEUTRONS (anti n)
- interactions anti $n + d$, total cross sections for, (E), 25:59275
- interactions anti $n + n$, total cross sections, (E), 25:59275
- interactions anti $n + p$, total cross sections for, (E), 25:59275

NEUTRONS, DELAYED
- energy spectra from uranium-235 fission, fast separation of bromine precursors for study of, 25:57504

NEUTRONS, EPITHERMAL
- scattering by carbon, chlorine, and hydrogen, amplitudes for coherent atomic, 25:59696

NEUTRONS, FAST
- dosimetry of, lithium hydride-doped lithium fluoride thermoluminescent dosimeter for, 25:57831(P)
- effects on alloys, interaction of coherent precipitates with damage in, 25:59163
- effects on aluminum, relations of chromium, copper, and vanadium contents on recovery from, 25:58303
- effects on chromosomes of Crepis capillaris seed, effects of time of onset of mitosis on frequency of aberrant,

  - 25:57968
  - effects on crystal structure of glass-forming arsenic--germanium--tellurium chalcogenide, 25:58419
  - effects on defect formation in titanium and rhenium at absolute melting temperature, 25:58302
  - effects on densities of stainless steel cladding materials, relations with void formation, 25:58306
  - effects on ESR and optical transmission spectra of α-silicon carbide monocrystals, 25:59154
  - effects on gallium arsenide junction field-effect transistors, improved tolerance to, 25:57905
  - effects on helium production in silver foils, 25:58334
  - effects on microstructure of molybdenum at 650°C, 25:58332
  - effects on tritium production in mixed oxide fuels, relations with burnup, 25:58344(R) (LA-4693)
  - effects on Type 304 stainless steel welds, relations with filler metal composition and welding processes, 25:58296 (HEDL-SA-196)
  - effects on void formation in alloys and metals, review of, 25:58305
  - effects on void formation in aluminum, copper, and magnesium, 25:58310
  - effects on void formation in high-purity aluminum, relations with fluence and flux, 25:58311
  - effects on void formation in metals, review of, 25:58299 (ORNL-TM-3495)
  - effects on void formation in molybdenum, niobium, and vanadium at 0.25 to 0.47 T/sub m/, 25:58309
  - effects on void formation in nickel, relations with subsequent electron irradiation, 25:58330
  - effects on void formation in stainless steel cladding materials, relations with microstructure, 25:58307
  - reactions (n,2n) at 14.8 MeV with A = 85 to 204 nuclei, cross sections and gamma spectra from, (E), 25:59797
  - reactions (n,2n) with germanium-76, selenium-82, and zinc-70 at 14.7 MeV, isomer ratios in, (E), 25:59766
  - reactions (n,2n) with yttrium-89 at 13.29 to 17.58 MeV, statistical-model analysis of excitation function for, (E/T), 25:59768
  - reactions (n,α) and (n,p) in cesium iodide at 12 to 22 MeV, analysis for pre-equilibrium emission mechanism in, (E/T), 25:59826
  - reactions (n,α) with A = 122 to 169 nuclei at 14.2 MeV, presence of direct effects in spectra from, (E/T), 25:59802
  - reactions (n,f) with uranium-236 at 0.8 to 6.7 MeV, energy dependence of prompt neutron yield from, (E), 25:59806
  - reactions (n,f) with uranium-238, evaluation of average neutron yield from, 25:59775 (AWRE-O-44/71)
  - reactions (n,p) with titanium-46 at 4.1 to 6.1 MeV, cross sections for, (E), 25:59755
  - reactions (n,p) with titanium-47 at 3.4 to 6.1 MeV, cross sections for, (E), 25:59755
  - reactions (n,p) with titanium-48 at 6.1 MeV, cross section for, (E), 25:59755
  - reactions with praseodymium-141 at 1 to 18 MeV, total cross section for, (E), 25:59811
  - reactions with water at 14-MeV, fast neutron spectra from pulsed, 25:59674
  - scattering by boron-11 at 14.1 MeV, coupled-channels calculation of angular distributions from elastic and inelastic, (T), 25:59720
  - scattering by cadmium-111, osmium-190, and yttrium-89 at 14.8 MeV, cross sections and gamma spectra from inelastic, (E), 25:59797
  - scattering by natural aluminum, phosphorus, and sulfur at 7.96 and 9.05 MeV, cross sections for elastic and inelastic, (E/T), 25:59770
  - scattering by natural magnesium at 7.97 MeV, cross sections for elastic and inelastic, (E/T), 25:59770
  - scattering by natural silicon at 7.71 to 9.05 MeV, cross sections for elastic and inelastic, (E/T), 25:59770
  - scattering by yttrium-89 at 2.69 to 18.07 MeV, statistical-model analysis of excitation function for inelastic, (E/T), 25:59768
  - spectra in subcritical assemblies, time-of-flight measurements of, (E/T), 25:60156(R) (GULF-RT-A-10800)
  - spectra measurements of, calculations for activation detectors for, 25:57775
  - streaming in fast test reactor grid-plate shielding, effects of sodium coolant holes configuration on, (E), 25:60158 (ORNL-TM-3514)
- NEUTRONS, FISSION
  - effects on ir absorption of polished gallium arsenide, spectral studies on, (E/T), 25:59155
  - effects on silicon and germanium, crystallinity and damaged regions in, (E/T), 25:59140
  - effects on void formation in nickel, relations with tensile stress, 25:58308
- NEUTRONS, INTERMEDIATE
  - capture by zinc at 10 to 80 keV, γ spectra from, (E), 25:59759
- NEUTRONS, PILE
  - effects on biaxial stress rupture of Type 316 stainless steel at 1000 to 1400°F, 25:58297 (HEDL-TME-71-72)
- NEUTRONS, THERMAL
  - age determination for, method for, (T), 25:59686
  - calculation of reactor physics constants for, computer program for, 25:60225 (JAERI-Memo-4394)
  - capture by chlorine-35, gamma linear polarization and coincidence spectrum from, (E), 25:59745
  - capture by platinum in acetylacetonate complexes, isotope effects on recoils from, 25:57489
  - capture by ytterbium-171 and -173, γ spectra and Q-values for, (E), 25:59825
  - capture by Z = 17 to 80 nuclei, gamma circular polarization from polarized, (E), 25:59780 (KFK-1401)
  - detection of, activation detector for, 25:57729(P)
  - diffusion length in moderators for, computer program for calculation of, 25:60226 (LFEN-NI.-60-a)
  - effects on carrier content, Hall mobility, and photoconductivity of n- and p-type cadmium telluride at 1 MeV, 25:59161
  - effects on catalytic activity of iron in ammonia synthesis, 25:57444
  - effects on mechanical properties of modified Hastelloy N, relations with composition, 25:58168 (ORNL-4676, pp 139-233)
  - reactions (n,f) with plutonium-239, absolute cross section for, (E), 25:59777 (IFA-NR-33)
  - scattering by simple fluids, theory of, 25:59678
  - scattering cross section for heavy water, computer code using Butler model for, 25:59689
- NEVADA TEST SITE
  - earthquake occurrences near, during 1950 to 1971, data summary on, 25:57589 (CGS-746-12)
  - radiation monitoring following venting of Baneberry underground nuclear test of December 18, 1970, 25:57993
- NEW ZEALAND
  - fallout monitoring during 1970, 25:57980(R) (HASL-245)
- NICKEL
  - analysis for cobalt, radiometric, 25:57356
  - atomic interaction potential for ion bombardment of polycrystalline, (T), 25:59145
  - content of foods in Kiev region of Soviet Union, 25:57987
  - copper adhesion to (111) crystal surfaces of, LEED study of, 25:58270
  - creep of sintered powder specimens of, effects of stress and time on, 25:58389(R) (SRO-552-8)
  - determination by extraction using quinolinol melt and spectrography, 25:57312
  - determination in cobalt alloys, spectrographic, 25:57313
  - determination in fuel solutions of JRR-1, 25:57320
  - determination in steel by neutron activation and radiochemical separation, 25:57381
  - determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
  - determination of trace amounts of, in tungsten trioxide or zirconium dioxide, effects of halide additives on direct spectrographic, 25:57335
  - effects on hardness of dispersion-hardening iron-base alloys, 25:58235
  - effects on mechanical properties of molybdenum single crystals, 25:58257
  - effects on niobium nitride solubility in iron austenite, 25:58268
  - effects on oxidation of hexavalent neptunium by potassium persulfate, 25:57412
  - etching by selective cavitation, method for, 25:58190
  - microstructure of sintered powders of, effects of initial particle size on, 25:58389(R) (SRO-552-8)
  - permeability of sintered powders of, relations with initial particle size, 25:58389(R) (SRO-552-8)
  - preparation of spheroidized powders of, using plasma heating, 25:58187(T) (SCL-T-710281)
  - radioinduced helium production in cladding materials of, neutron, 25:58336
  - radioinduced helium production in, measurement of in-pile, 25:58163(R) (AI-AEC-12859)
  - radioinduced helium release from boron-doped, neutron, 25:58335
  - radioinduced void formation in pure, relations of subsequent electron irradiation on fast neutron, 25:58330
  - radioinduced void formation in, at 280 to 600°C, electron microscopic study of electron, 25:58328
  - radioinduced void formation in, effects of tensile stress during irradiation on neutron, 25:58308
  - radioinduced void formation in, relations of subsequent electron irradiation on neutron, 25:58333
  - radioinduced void formation in, theory of, 25:58314
  - radioinduced void swelling in helium-containing, relations of dose with 20-MeV carbon ion, 25:58322
  - radioinduced void swelling in, use of high-voltage electron microscope to simulate fast neutron, 25:58326
  - separation from plutonium by solvent extraction using TBP, 25:57357
  - sintering of, parameters for activated, 25:58200
  - surface energy and work function of smooth faces of monocrystal of, (T), 25:59194
  - tensile properties of sintered-powder bars of, effects of porosity on, 25:58389(R) (SRO-552-8)
  - tungsten adhesion to (111) crystal surfaces of, LEED study of, 25:58270
- NICKEL 200
  - oxidation at 1000 to 1125°C in air, 25:57654(R) (DP-1279)
  - weld defects in, morphology of, 25:58215 (Y-DA-4280)

XUM

NICKEL ALLOY COUPLES
  Cr--Ni-base/Ni-base--Si, development of thermocouple of, 25:57876
NICKEL ALLOYS AND SYSTEMS
  coating with molybdenum and tungsten for corrosion protection, chemical vapor deposition method for, 25:58168 (ORNL-4676, pp 139-233)
  corrosion by air at 800 to 1300°C, effects of aluminum and chromium contents on, 25:58203
  oxidation resistance of IN-102, at 1500 to 2000°C in air, 25:58203
  preparation of corrosion-resistant high-strength superalloys of, review of methods for, 25:58203
  preparation of reference specimens of, methods for, 25:58179 (CONF-711002-, pp 47-58)
  radiation effects on tensile properties of IN-102, alpha particle, 25:58163(R) (AI-AEC-12859)
  Al--Cc--Cu--Fe-base--Ni, properties and structure of, effects of neodymium additions on, 25:58250
  Al--Cr--Ni-base--Ti, radiation effects on mechanical properties of, relations of temperature with neutron, 25:58295 (FRNC-TH-64)
  Al--Nb--Ni, preparation of fiber-strengthened composites of, method for, 25:58363
  Al--Ni, void formation in intermetallic NiAl single crystals, relations with microstructure, 25:58318
  Al--Ni-base, stability of intermetallic compounds and solid solutions in, thermal, 25:58224
  C--Cr--Fe--Hf--Mn--Mo--Nb--Ni-base--Si--Ti--Zr, radiation effects on mechanical properties of, relations of composition with thermal neutron, 25:58168 (ORNL-4676, pp 139-233)
  C--Cr--Fe--Ni--Si--W, metallography of carbide structures in cast heat-resistant, 25:58399
  C--Mo--Ni, phase composition in molybdenum-rich solutions of, at 1200 to 1800°C, 25:58290
  C--Ni, preparation of metal-matrix composites of, methods for, 25:58363
  Co--Fe-base--Mo--Ni, aging of, dilatometric, electric conductivity, and electron microscopy studies on, 25:58232
  Cr--Ni, porosity and pressure strength of boron-containing, for use as neutron absorber, 25:58255
  Cr--Ni, production of boron-containing neutron absorbers of, using powder metallurgy, 25:58255
  Cu--Ni, welding to steel, deposition of intermediate layers for, 25:58204
  Fe--Ni--V, electric, magnetic, and mechanical properties of $Ni_3(Fe,V)$ solid solutions, 25:59188
  Fe-base--Mo--Ni, aging of, dilatometric, electric conductivity, and electron microscopy studies on, 25:58232
  Mo--Ni, hardness and structure of electrodeposited, 25:58256
  Ni--V, oxidation in air at 1000°C, activation energy for, 25:58251
  Ni--W, hardness of electrolytically deposited, relations of internal stresses with micro-, 25:58236
  Ni--Zr-base, properties of dilute cast, electric and mechanical, 25:58258
NICKEL CARBIDES
  joining to high-strength materials by continuous seam diffusion bonding, 25:58201
NICKEL IONS
  spectra in x-irradiated sodium chloride, ESR, 25:59201
NICKEL ISOTOPES
  neutron pairing in, equilibrium, (T), 25:59833 (JINR-E4-5907)
NICKEL ISOTOPES Ni-56
  production in stars from simple helium burning, (E), 25:58508
NICKEL ISOTOPES Ni-58
  deuteron elastic scattering at 80 MeV, optical-model analysis of angular distributions from, (E), 25:59754
  deuteron inelastic scattering at 82 MeV, DWBA analysis of angular distributions from, (E), 25:59754
  energy levels from inelastic scattering, deformation parameters for, (E), 25:59754
NICKEL ISOTOPES Ni-60
  helium-3 elastic scattering at 30 MeV, optical-model analysis of differential cross sections for, (E), 25:59769
  photon reactions (γ,n) up to 35 MeV endpoint energy, excitation functions for, (E), 25:59772
  proton reactions (p,γ) near 1.6 MeV, γ spectra and angular distributions for, (E), 25:59764
NIMONIC PE 16
  radiation effects on density of, relations of void formation with fast neutron, 25:58306
  radioinduced void formation in, electron microscopic study of annealing of, 25:58307
  radioinduced void swelling in helium-containing, relations of dose with 20-MeV carbon ion, 25:58322
NIOBIUM
  analysis for oxygen by 14-MeV neutron activation and γ spectrometry, 25:57376
  Debye--Waller factor of, temperature dependence of, 25:59179
  determination by spectrography, elimination of effect of sample composition on, 25:57330
  determination in alloys using magneson, photometric, 25:57315
  determination using diantipyrylpropylmethane, pyrocatechol, and pyrogallol, spectroscopic, 25:57316
  determination using rezarson, spectrophotometric, 25:57333
  machining of cylindrical apertures in, by electroerosion, 25:58193
  oxidation of, effects of interstitial oxygen content on, 25:58172
  preparation of radiation targets of, by argon ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
  production and purification of, using aluminothermic reduction and electrorefining, 25:58202
  radioinduced void formation in, electron microscopic study of fast neutron, 25:58309
  radioinduced void formation in, neutron, 25:58300 (ORNL-TM-3496)
  separation from oxalic and tartaric acids by solvent extraction using tributylamine, 25:57546
  separation of berkelium from, by sorption on zirconium phosphate--silicate, 25:57530
  solubility in sodium at high temperatures, 25:58163(R) (AI-AEC-12859)
  surface energy and work function of smooth faces of monocrystal of, (T), 25:59194
NIOBIUM ALLOYS AND SYSTEMS
  joining to high-strength materials by continuous seam diffusion bonding, 25:58201
  preparation of reference specimens of, methods for, 25:58179 (CONF-711002-, pp 47-58)
  Al--Ge--Nb, properties of superconducting, 25:58948
  Al--Nb--Ni, preparation of fiber-strengthened composites of, method for, 25:58363
  C--Cr--Fe--Hf--Mn--Mo--Nb--Ni-base--Si--Ti--Zr, radiation effects on mechanical properties of, relations of composition with thermal neutron, 25:58168 (ORNL-4676, pp 139-233)
  Co-base--Nb, microstructure of decomposing supersaturated solid solutions, 25:58280
  D--Nb--Ti, deuterium distribution fluctuations in $NbTi_2D$, 25:58278
  Hf--Nb, electric conductivity from 4 to 300°K, 25:58929 (FRNC-TH-72)
  Mo--Nb, composition of electronic-melted zone liquation-produced, 25:58260
  Mo--Nb, solvent properties for nitrogen at high temperatures, 25:58249
  Mo--Nb-base, creep at 1100 to 1300°C, effects of molybdenum content on steady, 25:58222
  Mo--Nb-base--Zr, machining characteristics of, at high and low temperatures, 25:58198
  Mo-base--Nb, thermal cycling of monocrystals of, dimensional effects of, 25:58247
  Nb--Sn, Kohn instability in Labbe--Friedel model of Nb_3Sn, (T), 25:58947
  Nb--Ti, microstructure of superconducting, effects of heat treatment on, 25:58942
  Nb--UO_2-base, preparation of dense homogeneous, method for, 25:58348 (LFEN-NI.-53-a)
  Nb--W, composition of electronic-melted zone liquation-produced, 25:58260
  Nb--Zr-base, fabrication of calandria and pressure tubes of, for Japanese reactors, 25:58194
  Nb-base--Zr, radioinduced void formation in, neutron, 25:58300 (ORNL-TM-3496)
NIOBIUM CARBIDES
  machining of, effects of carbon content in corresponding ranges of homogeneity on electroerosion, 25:58356
NIOBIUM FLUORIDES
  disproportionation of NbF_4, 25:57298 (ORNL-4676, pp 73-138)
  mass spectra of, 25:57298 (ORNL-4676, pp 73-138)
  reactions in molten lithium beryllium fluoride solutions, kinetics of, 25:57298 (ORNL-4676, pp 73-138)
NIOBIUM ISOTOPES Nb-95
  chemical state in seawater, effects of iron on, 25:57410
NIOBIUM NITRIDES
  solubility in iron austenite, effects of chromium, manganese, nickel, and silicon on, 25:58268
NIOBIUM OXIDES
  crystal defect structure of oxygen-deficient Nb_2O_5, model for, 25:58391
  effects of doping agent of, on fission product retention by uranium oxide fuel particles, 25:58347 (JUL-730-RW)
  reduction to metal, aluminothermic, 25:58202
  CaO--Nb_2O_5--SiO_2--TiO_2, liquidus of pseudo-ternary $CaO.Nb_2O_5$--$CaO.TiO_2$--SiO_2 plane of, 25:58390
NITRATE REDUCTASE
  radiation effects on synthesis of, in Ustilago, uv, 25:57955
NITRIC ACID
  HCl--HNO_3, properties of etchant of, for uranium dioxide, 25:58244
  HNO_3--$Sr(NO_3)_2$, radiolysis of citric acid in solutions of, γ, 25:57457 (ARH-2163)
NITROCELLULOSE
  use in preparation of thin-film radiation targets, methods for, 25:59639 (CONF-711002-, pp 134-43)
NITROGEN
  abundance in iron meteorites, (E), 25:58423
  content of blood of rabbits and rats following administration of mercuric bichloride and uranium,

XUM

25:58099
- determination in presence of fission products by neutron activation, automated system for, 25:57390
- deuterium-hydride scattering by molecular, velocity dependence of total effective cross sections for, 25:58782
- deuterium-molecule scattering by molecular, velocity dependence of total effective cross sections for, 25:58782
- effects on γ and x radioinduced mutations in bacteriophage phi X174, 25:57971
- effects on tungsten evaporation rate in strong electric fields, 25:58227
- electron reactions with molecular, K--LL Auger spectra from, (E), 25:58736
- energy levels of, modified relativistic Hartree--Fock approximation for $(2p)^3$ ground-state, 25:58800
- helium-atom scattering by molecular, velocity dependence of total effective cross sections for, 25:58782
- iodine-ion reactions at 12 MeV with molecular, electron-capture and -loss cross sections for, (E), 25:58768
- ion reactions in keV range with molecular, effects of velocity and outer-shell configuration on K-vacancy production in, (E), 25:58756
- nitrogen-ion (N_2^+) reactions at 1 to 45 eV with molecular, effects of ion excited states on cross sections for, (E), 25:58751
- nitrogen-ion (N^+) reactions at 1 to 70 eV with molecular, cross sections and mechanisms of charge exchange in, (E/T), 25:58735
- radioinduced fixation of, 25:57442
- reactions with sodium (3^2P) atoms of molecular, cross sections for excitation in, (E), 25:58778
- reactions with zirconium surfaces, effects of impurities on, 25:58173
- solubility in chromium, molybdenum, niobium, tantalum, and tungsten at high temperatures, 25:58249

NITROGEN IONS
- effects on microstructure of molybdenum at 2 MeV and 870°C, 25:58332
- effects on regular void array in high-purity molybdenum and TZM at high temperatures and 2 MeV, 25:58340
- electron reactions with N^{2+}, cross sections for ionization in, (E), 25:58769
- excitation of positive molecular, electron impact cross section for, (E), 25:58726
- implantation in silicon carbide at 30 keV, 25:59171
- reactions with celluloid films of multiply charged, film-thickness dependence of cross sections for electron capture and loss in, (E), 25:58695

NITROGEN IONS (N^+)
- reactions with neon and nitrogen molecules in keV range, production of K vacancies in, (E), 25:58756
- reactions with nitrogen molecules at 1 to 70 eV, cross sections and mechanisms of charge exchange in, (E/T), 25:58735

NITROGEN IONS (N_2^+)
- reactions with nitrogen molecules at 1 to 45 eV, effects of ion excited states on cross sections for, (E), 25:58751

NITROGEN ISOTOPES
- determination of, mass spectrometer for, 25:57890

NITROGEN ISOTOPES N-14
- meson reactions $(\pi^+,2p)$ at 70 MeV, excitation spectra for, (E), 25:59709 (LA-DC-12389)
- proton inelastic scattering by, approximate G-matrix calculations for, (T), 25:59858
- reactions (N-14,Li-6) with carbon-12 at 60.0 MeV, energy spectrum from, (E), 25:59743

NITROGEN ISOTOPES N-15
- effects on rotational spectra of ammonia in 0.5-mm wavelength region, 25:57424

NITROGEN OXIDES NO
- density of (NO^+) in F-region nightglow, (E/T), 25:58884
- deuterium-hydride scattering by, velocity dependence of total effective cross sections for, 25:58782
- deuterium-molecule scattering by, velocity dependence of total effective cross sections for, 25:58782
- electron reactions at 13 to 18 eV with, production of oxygen ions (O^-) by dissociative attachment in, (E), 25:58730
- electron reactions with, K--LL Auger spectra from, (E), 25:58736
- helium-atom scattering by, velocity dependence of total effective cross sections for, 25:58782
- iodine-ion (I^-) reactions with, effects of thermal motion of molecules on charge exchange in, (T), 25:58752

NITROGEN OXIDES NO_2 OR N_2O_4
- electron paramagnetic spectrum in potassium chloride, hindered rotation from, 25:59199 (NYO-2150-74)
- electron reactions at 60 eV with, production of excited oxygen ions (O^+) in, (E), 25:58763
- sodium-atom reactions at 1 to 30 eV with, light emission and excitation cross sections for, (E), 25:58749

NITROGEN OXIDES N_2O
- electron reactions at 60 eV with, production of excited oxygen ions (O^+) in, (E), 25:58763
- electron reactions at 7 to 15 eV with, production of oxygen ions (O^-) by dissociative attachment in, (E), 25:58730
- iodine-ion reactions at 12 MeV with, electron-capture and -loss cross sections for, (E), 25:58768

NITROGEN SYSTEMS
- He--N, ion production and loss processes in plasma of, (E), 25:59014
- N--Ne, plasma decay in mixtures of, ion production and loss in, (E), 25:59019

NOBELIUM
- oxidation potential for trivalent--tetravalent, 25:57437

NOISE
- detection methods for boiling in liquid sodium, development of, 25:60090
- detection methods for boiling, development of, 25:60181

NORTH AMERICA
- fallout deposition on, during Jan. 1964, effects of major stratospheric--tropospheric mass exchanges on, 25:57572(R) (COO-1340-24)
- fallout monitoring during 1970, 25:57981(R) (HASL-245(App.))
- radioactivity of surface atmosphere and precipitation sampled during March 1971, gross β, 25:57992
- radioisotope content of milk during March 1971, barium-140, cesium-137, iodine-131, strontium-89, and strontium-90, 25:57990

NORTH ANNA POWER REACTOR, UNIT 1
- construction of, request for not suspending permit for, 25:59985 (DOCKET-50338-32)

NORTH ANNA POWER REACTOR, UNIT 2
- construction of, request for not suspending permit for, 25:59985 (DOCKET-50338-32)

NOSE CONES
- fabrication of carbon felt, infiltrated with pyrolytic carbon, 25:58352 (Y-DA-2123(Rev.1))

NOVAE
- spectra of DQ Her, hydrogen lines in, (E), 25:58426
- spectra of Herculis 1963, Balmer absorption lines in, (E), 25:58436
- spectra of Serpentis 1970, recovery and final decline of, (E), 25:58450

NPD REACTOR
- fuel burnup in, methods for analysis of, (E/T), 25:60093 (AECL-3995)

NUCLEAR AUXILIARY POWER SYSTEMS
- development for spacecraft, review on, 25:57671

NUCLEAR CHEMISTRY
- research program at Los Alamos Meson Physics Facility, 25:59642 (LA-DC-12795)
- research progress on, 25:57442

NUCLEAR EMULSIONS
- cosmic nuclei reactions with light nuclei above 700 MeV/nucleon in, energy distribution and mean energy of nonrelativistic doubly charged particle production in multicharged, (E), 25:59274
- meson reactions $(\pi^-, 2\pi^-\pi^+)$ and $(\pi^-, 3\pi^- 2\pi^+)$ with nuclei at 17 and 45 GeV in, mean free paths for coherent, (E), 25:59313
- processing for discrimination of alpha and recoil proton tracks, 25:57731
- proton reactions at 28 GeV with, energy spectra of lithium-8 fragments from, (E), 25:59278
- sensitivity at low temperatures, 25:57829

NUCLEAR EXPLOSIONS
- yields of, estimation using microbarograph data, (E/T), 25:57606

NUCLEAR EXPLOSIONS, ATMOSPHERIC
- book: Protection of Animals Against Injury by Nuclear Weapons, 25:58026
- effects of Chinese, on cesium-144 content of Fayetteville, Arkansas atmosphere, 25:57578
- effects of Chinese, on strontium-90 content in Japanese atmosphere and northern hemisphere stratosphere, 25:57579
- effects on sodium-22 content of USSR rivers, 25:57568
- fallout from 10th Chinese, monitoring in Swedish atmosphere, 25:57580
- fallout monitoring from Dec. 28, 1968 Chinese, in Swedish atmosphere, 25:57577

NUCLEAR EXPLOSIONS, UNDERGROUND
- bibliography of civil, industrial, and scientific uses for, 25:57603 (TID-3522(Rev.9))
- containment of Jorum Event, method for pre-shot calculation of, 25:57607
- detection of, Indian seismology research on methods for, 25:57591 (INIS-mf-71, pp 181-98)
- discrimination between earthquakes and, using seismic P-wave spectra, 25:57599
- discrimination between earthquakes and, using short period seismic array data, 25:57600
- effects of Milrow, on seismic activity in Amchitka Island region, 25:57597
- effects on seismic activity near Nevada Test Site from 1950 to 1971, (E), 25:57589 (CGS-746-12)
- ground motion from, at Amchitka Island, method for prediction of, 25:57602 (SC-RR-69-376)
- list of June 1970, 25:57993
- natural gas production stimulation by, method for decontamination of product from, 25:57605(P)
- radiation monitoring following venting of Baneberry, December 18, 1970, 25:57993
- seismic waves from, generation and propagation of P, R, and S, 25:57593 (TID-25572)
- seismological effects of Cannikin Event, at Amchitka

XUM

  Island, Alaska, studies of potential, 25:57590 (COO-2138-4)
  use for copper ore fracturing, method for ore processing of decontaminated copper following, 25:57523 (ORNL-4677)
  use to construct chimneys for chemical mining of copper and waste disposal, 25:57604 (UCRL-73130)
NUCLEAR MATERIALS MANAGEMENT
  control systems for, in conversion plants, standards for, 25:57717
  inventories for, standards for conducting, 25:57715
  methods for, computer-controlled, 25:57897
  nuclear safeguards measurements using photonuclear reactions, equipment and methods development for, 25:57704 (GULF-RT-A-10826)
NUCLEAR MATTER
  energy and defect parameters for dense neutron, calculations using Hamada--Johnston hard-core and Reid and Bressel--Kerman--Rouben soft-core potentials, (T), 25:59866
  forces in, theory of two-body effective, (T), 25:59850
NUCLEAR MODELS
  alpha-particle, saturation properties of residual binding energy in, (T), 25:59725
  shell, antisymmetrized weak coupling scheme for, (T), 25:59857
  unified, development from independent-particle and liquid-drop models, (T), 25:59849
NUCLEAR POWER
  development in Australia during July 1970 to June 1971, 25:60276(R) (NP-19036)
  development of, conference on, 25:60006 (CONF-700113)
  requirements for, estimates of long-range, 25:60020
NUCLEAR POWER PLANTS
  condenser water cooling for, effects of spinning disks in ponds for, 25:60023
  construction in Japan, civil engineering aspects of, 25:59895
  construction of, delays in schedules for, 25:59893
  development in Europe, 25:59901
  development in Federal Republic of Germany, predictions to 1980, 25:59889
  development in India, status of, 25:59891
  development in Japan, economic and safety aspects of, 25:59905
  development in Japan, effects of uranium enrichment technology on, 25:59904
  development in Japan, petroleum industry competition for, 25:59903
  development in Japan, projections of, 25:59906
  development in Sweden, 1970 status of, 25:59890
  development in U.S., public opinion on, 25:60129
  development of, data summary on, 25:59900
  development of, economics for 1975 to 1995 for worldwide, 25:59888
  development of, economics for worldwide, 25:59887
  economics in Australia, 25:59919
  economics in Yugoslavia, 25:60108
  economics of, effects of generating cost variables on, 25:59920
  electric power production by UK, forecasts to year 2000, 25:57633
  integration in New England Power Exchange System, 25:59907 (CONF-710606-15)
  operation in mixed generation utility systems, control optimization of, 25:59922
  power generation cycle for, with means for storing heat during reduced load operation, 25:60143(P)
  radioactive effluents from U.S., public opinion on guidelines for, 25:60128
  response to earthquakes, models for simulating dynamic, (T), 25:57598
  siting of U.S., public participation in regulation of, 25:60004
  siting of, economic, environmental, and safety aspects of, 25:60119
  valves for BWR-type, design of safety, 25:57637
NUCLEAR REACTION ANALYSIS
  method of (p,α), for determination of light impurities in bulk heavy material, 25:57360
NUCLEAR REACTIONS
  book: Scattering, Reactions, and Disintegrations in Nonrelativistic Mechanics (in Russian), 25:59612
  cross sections for charged-particle, neutron, and proton, description of LRL evaluated library of, (E), 25:59783 (UCRL-50400(Vol.4))
  cross sections for heavy-ion multinucleon-transfer, Q-value dependence of, (T), 25:59845
  Hauser--Feshbach theory for compound, time reversal invariant formulation of, 25:59873
  nuclear materials safeguards research with photon-induced, 25:57704 (GULF-RT-A-10826)
  particle polarization and spin correlations in, X-coefficients for, 25:59881
  polarization effects in nucleon transfer, (T), 25:59831 (IFA-CRD-41)
  potentials for, finite-difference solution of Schroedinger equation for axially symmetric single-particle, (T), 25:59839 (LA-4735)
  research at Rice Univ., 1969 to 1970, (E/T), 25:59692(R) (ORO-1316-99)
  resonance phenomena in, model for analysis of, (T), 25:59876
  theory for compound nucleus, role of angular momentum and isobaric spin in tests of independence hypothesis for, (T), 25:59830 (CU-1019-82)
  theory of resonance, review of line broadening in, (T), 25:59847
NUCLEAR REACTIONS (DIRECT)
  Coulomb excitation in, DWBA calculation of differential cross sections for quadrupole, (T), 25:59859
  cross sections in deuteron stripping, DWBA treatment of finite-range effects in calculation of differential, (T), 25:59854
  deuteron stripping, finite-range interactions in DWBA treatment of, (T), 25:59841(R) (CRC-4119-1)
  isospin T = 0 and T = 1 transfers in (He-3,p), effects on angular distributions of, (T), 25:59741
  theory of (d,p) stripping, (T), 25:59848
NUCLEAR STRUCTURE
  calcuations for low-lying spectra in spherical nuclei, including long-range effective interactions, 25:59884
  deformation and compressibility in Hartree--Fock field, 25:59877
  nucleon--nucleon potential, one-pion-exchange contribution to weak P- and T-violating, 25:59408
  research at intermediate energies at Rice Univ., 1970 to 1971, (E/T), 25:59693(R) (ORO-1316-100)
  Siegert's theorem in, applicability of, (T), 25:59864
NUCLEAR THEORY
  book: Theory of Complex Nuclei, 25:59875
  decays in 2s-1d-shell nuclei, comparison of analogous $\Delta T = 0$ beta and gamma, 25:59844
  Hartree--Fock calculations in s-d shell, effect of spin-dependent forces on, (T), 25:59878
  isobaric mass equation in, parameters for T = 3/2 multiplet in A = 4n + 1 nuclei, 25:59882
  nucleon--nucleon potential in, nature of two-pion exchange contribution to, 25:59870
  potentials in two-, three-, and infinite-nucleon systems in, separable, 25:59517
NUCLEI
  alpha elastic scattering by spinless, Regge-pole and partial-wave analysis of glory scattering in backward, (T), 25:59846
  alpha reactions with light, at low energies, cross sections and polarization effects in nucleon transfer, (T), 25:59831 (IFA-CRD-41)
  alpha-cluster configurations in light, calculation using Skyrme interaction, (T), 25:59883
  baryon resonance reactions with A > 4, probability for multibaryon resonances from, 25:59521
  beta decay far from stability line, review of study of, (T), 25:59835 (KURRI-TR-76, pp 1-2)
  beta decay of heavy, calculation of half-lives and strength functions for allowed and first-forbidden, (T), 25:59868
  binding energies of alpha-particle, saturation properties of residual, (T), 25:59725
  binding energy of one-dimensional N-body systems with inverse and inverse-square pair potentials, (T), 25:59840 (NP-19027)
  binding energy of, estimates of harmonic-oscillator potential-energy effects in intermediate states in calculations of, (T), 25:59862
  binding energy of, separable potentials for, (T), 25:59517
  Coulomb displacement energies in mirror, correction of isovector monopole state to, (T), 25:59871
  Coulomb energies and second energy differences in A = 18 to 42, calculations including pairing residual interactions, (T), 25:59860
  decays of 2s-1d-shell, comparison of analogous $\Delta T = 0$ beta and gamma, (T), 25:59844
  electrodisintegration through giant resonance and quasielastic regions, strong-coupling particle-hole analysis of, (T), 25:59869
  electron elastic scattering by, radiative corrections for, 25:59880
  energy levels from neutron capture by Z = 16 to 57, spin assignments for, (E), 25:59780 (KFK-1401)
  energy levels from neutron resonances in Z = 42 to 80, spin assignments for compound-state, (E), 25:59780 (KFK-1401)
  energy levels from pickup reactions, calculation of energy-weighted averages of spectroscopic factors for, (T), 25:59855
  energy levels of deformed odd--odd, β-strength functions for 0^+ and 1^+ unlike particle-hole, (T), 25:59872
  energy levels of one-dimensional N-body systems with inverse and inverse-square pair potentials, exact ground-state, (T), 25:59840 (NP-19027)
  energy levels of, delayed-coincidence and recoil-distance techniques for measuring lifetimes of, (E), 25:59771
  energy levels of, displacement of dipole isodoublet, (T), 25:59853
  energy-level transitions in, applicability of Siegert's theorem to electric, (T), 25:59864
  energy-level transitions in, effects of nonlocal BCS pairing interaction in electric, (T), 25:59863
  fission of, ambiguities in R-matrix parameters for interfering resonances with two channels for, (T), 25:59829 (COO-2022-11)

XUM

- fission of, pairing gap parameters and transition points in pairing-plus-quadrupole model of, (T), 25:59867
- forces in, theory of two-body effective, (T), 25:59850
- helium-3 reactions (He-3,p) with odd--even, isospin effects on angular distributions from, (T), 25:59741
- meson (π) reactions at 0.01 to 100 GeV, cascade evaporation model for Monte Carlo method for calculating, (T), 25:59508(T) (ORNL-tr-2514)
- meson (π) reactions with, absorption and dispersion corrections to πN optical potential for, 25:59516
- meson (π^-) reactions with light, at 4 GeV/c in freon bubble chamber, cross sections and mass distributions for coherent production of $\pi^+ 2\pi^-$ system in, (E), 25:59316
- meson reactions (π^-, $2\pi^- \pi^+$) and (π^-, $3\pi^-$ $2\pi^+$) at 17 and 45 GeV in emulsions, mean free paths for coherent, (E), 25:59313
- neutrino emission from, in hot dense stars, (T), 25:58492
- neutrino reactions ($\nu, \mu^- W^+$) at high energies, angular and energy distributions for W production in, 25:59410
- neutrino reactions with, angular and momentum distributions of μ^+ and e^+ in direct production of lepton pairs in, (T), 25:59415
- neutrino reactions with, Coulomb corrections to Adler PCAC test in, 25:59406
- neutron capture by $Z = 17$ to 80, gamma circular polarization from polarized thermal, (E), 25:59780 (KFK-1401)
- neutron cross sections of fissile, effect of level interference on slow, (T), 25:59879
- neutron decay of, possible examples of two-, (T), 25:59740
- nucleon inelastic scattering by, DWBA analysis using realistic nucleon--nucleon interactions of, (T), 25:59858
- nucleon reactions at 0.01 to 100 GeV, cascade evaporation model for Monte Carlo method for calculating, (T), 25:59508(T) (ORNL-tr-2514)
- photon reactions (γ, e^+e^-) with, vector dominance model for rho--ω mixing in, 25:59364
- photon reactions with, ENDF formats and procedures for storage of data on, (T), 25:59838 (LA-4549)
- positron elastic scattering by, radiative corrections for, 25:59880
- properties of short-lived, conference on measurement of, (E), 25:59834 (KURRI-TR-76)
- properties of short-lived, review of properties of, (E), 25:59782 (KURRI-TR-76, pp 21-6)
- properties of, reaction-matrix theory of ground-state, (T), 25:59851
- proton decay of, possible examples of two-, (T), 25:59740
- proton reactions (p,n) at 23 MeV with $A = 26$ to 165, spectra and DWBA analysis of angular distributions from, (E), 25:59789
- proton reactions with, isobaric-spin conservation for proton emission probability in compound-nucleus, (T), 25:59830 (CU-1019-82)
- reactions with light nuclei above 700 MeV/nucleon in emulsions, energy distribution and mean energy of nonrelativistic doubly charged particle production in, (E), 25:59274
- resonances with two fission channels in, ambiguities in R-matrix parameters for interfering, (T), 25:59829 (COO-2022-11)

NUCLEI (CELLS)
- radiation effects on macro- and micro-, of Stylonychia, x, 25:58096

NUCLEIC ACID
- radiation effects on content in above-ground parts and roots of pea and wheat plants, γ, 25:57941

NUCLEIC ACID, DEOXYRIBO-
- characterization and fractionation of tobacco leaf transfer, 25:60284 (RLO-2225-T-15-7)
- radiation effects on Escherichia coli, role of endonuclease in repair of uv, 25:57928
- radiation effects on Micrococcus luteus, role of nucleases in repair of uv, 25:57935
- radiation effects on synthesis in Chlamydomonas, dark repair of uv, 25:57925
- radiation effects on synthesis of amphibian embryo, effects of dose on x, 25:57944
- radiation effects on synthesis of HeLa cells, effects of 5-fluorouracil on uv, 25:58082
- radiation effects on, review of neutron, 25:58089
- radioinduced breaks in mammalian, review of repair mechanisms for uv and x, 25:57943
- radioinduced single- and double-strand breaks in phi X-174 replicative form of, effects of LET on, 25:57952 (LBL-28)
- radioinduced single-strand breaks in human lymphocyte, kinetics of repair of electron, 25:57958
- radioinduced synthesis in polytene chromosomes of Drosophila, uv and x, 25:57951 (COO-1747-6)
- repair in irradiated bacteria in relation to chromosome recovery, 25:57970
- role of tritium-labeled, in radioinduced death of mammalian cells, 25:58086
- strand break repair in human, 5-bromodeoxyuridine photolysis mechanisms for, 25:60268 (CONF-711014-1)

NUCLEIC ACID, RIBO-
- radiation effects on synthesis of amphibian embryo, effects of dose on x, 25:57944
- radiation effects on, of rats in relation to central nervous system, x, 25:58098

NUCLEOGENESIS
- element production in simple helium burning, (E/T), 25:58508
- heavy-element enrichment by, (T), 25:58636
- products of rapid neutron capture on surfaces of peculiar A stars, (E/T), 25:58462

NUCLEONS
- form factor and structure function in parton model, electromagnetic, 25:59431
- form factors from current algebra, Regge poles, and Veneziano model, axial-vector, 25:59356
- form factors in quark--parton model, 25:59391
- form factors of, high-energy behavior of, 25:59339
- interaction $\gamma + N \to \pi^0 + N$, PCAC hypothesis from s-wave threshold amplitudes of, (E/T), 25:59373
- interactions anti K + N at 0 to 1400 MeV/c, energy-dependent multichannel M-matrix fits to partial-wave analyses of, (T), 25:59476
- interactions anti $K^0 + N \to K + \Xi$ at 2 to 5 GeV/c, Regge cut model for near-forward differential cross sections for, 25:59483
- interactions anti $\nu + N \to \mu^+ +$ meson + baryon, urbaryon model of hadrons for, 25:59394
- interactions $e + N$ in parton model, scaling in deep inelastic, 25:59431
- interactions $e + N$, relativistic model for inelastic form factors, widths, and locations of N^* production in, (T), 25:59337
- interactions $e^- + N \to e^- + N$ at high energies and low momentum transfers, Compton scattering cross sections for two-photon-exchange contribution to, (T), 25:59372
- interactions $e^+ + N \to e^+ + N$ at high energies and low momentum transfers, Compton scattering cross sections for two-photon-exchange contribution to, (T), 25:59372
- interactions $\gamma + N \to \pi + N$, vector meson dominance of k^2 dispersion relation for invariant amplitudes for π production in, (T), 25:59351
- interactions $\gamma + N$, classical charge-symmetric field theory for cross sections for scalar meson production in, (T), 25:59338
- interactions $\gamma + N$, field theoretical basis for weak-interaction theory for, (t), 25:59397
- interactions $\gamma + N$, nonleading Regge behavior and fixed poles with polynomial residues in Compton, 25:59381
- interactions K + N, empirical analysis of differences and sums of angular distributions for duality in, (T), 25:59477
- interactions K + N, modified Pomeranchuk theorem for lower bounds on elastic and charge-exchange, 25:59474
- interactions $K^+ + N \to K^0 + p + p$ at 5.5 GeV/c, partial cross section and momentum transfer distribution for, (E), 25:59305
- interactions $K^- + N \to \Lambda + \pi$ at 1 to 1.85 GeV/c, partial-wave analysis of, (E), 25:59303
- interactions $K^- + N$ at intermediate energy, dual structure of amplitudes for, 25:59504
- interactions $\Lambda + N$, charge-symmetry breaking in, (T), 25:59515
- interactions $N + N \to N + N + \gamma$ in soft photon region, elastic NN phase shifts from, (E/T), 25:59520
- interactions $N + N \to N + N + \gamma$, review of, (E), 25:59241 (CONF-710915-2)
- interactions N + N at high and superhigh energies, Monte Carlo method with energy--momentum conservation law for analytical approximations for reconstruction of inelastic, (T), 25:59472 (JINR-P2-6022)
- interactions N + N at high energies, quasipotential theory of, 25:59442
- interactions N + N in pre-asymptotic region, angular distributions and amplitude structure for inelastic, (T), 25:59497
- interactions N + N with vector-meson exchange, radiative corrections to relativistic eikonal amplitude for, (T), 25:59453
- interactions $\nu + N \to l +$ meson + baryon, urbaryon model of hadrons for, 25:59394
- interactions $\nu + N \to \mu^- +$ meson + baryon, urbaryon model of hadrons for, 25:59394
- interactions $\nu + N \to \mu^- + W^+ + N$, μ^- angular and momentum distributions for, (T), 25:59414
- interactions $\nu + N$ at high energies, μ spectra from, (T), 25:59417
- interactions of, comparison of models for relation of amplitude for deuteron production in deuteron interactions with amplitude for nucleon production in, (T), 25:59514
- interactions $\pi + N \to$ eta + N, dispersion theoretic model for $S_{11}(1525)$ resonance and cross sections for, 25:59486
- interactions $\pi + N \to m\pi + N$, one-pion-exchange model for effective mass spectrum of π system in, (T), 25:59496
- interactions $\pi + N \to \pi + \Lambda + K$ at 7 GeV/c, production of $N^*(1700)$ in, 25:59307
- interactions $\pi + N$ at high and superhigh energies, Monte Carlo method with energy--momentum conservation law for analytical approximations for reconstruction of inelastic, (T), 25:59472 (JINR-P2-6022)

XUM

- interactions π + N at threshold to 13 GeV/c, predictions of isospin invariance in backward, (E/T), 25:59287
- interactions π + N in pre-asymptotic region, angular distributions and amplitude structure for inelastic, (T), 25:59497
- interactions π + N, complex Regge poles in backward, (T), 25:59495
- interactions π + N, generalized potential and P_{33} phase shift for, 25:59485
- interactions π + N, invariant amplitudes in unphysical region for, 25:59481
- interactions π + N, low-energy π + π interaction from phase shifts for, 25:59463
- interactions π + N, modified Pomeranchuck theorem for lower bounds on cross sections for elastic, 25:59474
- interactions π + N, parity violation from longitudinal polarization of recoil nucleon in, 25:59487
- interactions π + N, reconstruction of amplitudes from experimental data for, 25:59498
- interactions rho + N from photoproduction of e^+--e^- pairs at 4 GeV, real forward scattering amplitude for, (E), 25:59252
- interactions Σ + N at low energies, parameters for, (T), 25:59525
- interactions with leptons, relativistic model for inelastic form factors, widths, and locations of N* production in, (T), 25:59337
- production in proton reactions with iron at 400 GeV, Monte Carlo calculations of star and flux distributions from, (T), 25:59507 (ORNL-4673)
- reactions with nuclei at 0.01 to 100 GeV, cascade evaporation model for Monte Carlo method for calculating, (T), 25:59508(T) (ORNL-tr-2514)
- scattering by calcium-40 at 14 MeV, optical model analysis of, (T), 25:59744
- scattering by nuclei, DWBA analysis using realistic nucleon--nucleon interactions of inelastic, (T), 25:59858
- theory for KN system, quasipotential formalism for field-theoretic and phenomenological analysis in, (T), 25:59422 (JINR-E2-6046)
- theory for πN system, quasipotential formalism for field-theoretic and phenomenological analysis in, (T), 25:59422 (JINR-E2-6046)
- theory for separable potentials in two-, three-, and infinite-N systems of, (T), 25:59517

NUCLEOTIDES
- radiation effects on adenine, in different degrees of phosphorylation in rat liver and kidney, 25:57936
- radiation effects on release of, from Micrococcus luteus DNA, uv, 25:57928
- role in excitability characteristics of nerve fibers, use of uv radiation in studies of, 25:57939

O

OAK RIDGE AREA (TENN.)
- radioactivity monitoring during 1969, 25:57985

OBSIDIAN
- age of, fission track and uranium content method for estimation of, 25:57569
- uranium content of volcanic, geologic origin of, 25:57569

ORDNANCE MATERIEL
- detection of high explosives, neutron capture gamma-ray techniques for, 25:57866 (SC-RR-710450)

ORES
- analysis for niobium, spectrophotometric, 25:57333
- processing of, following nuclear fractionation development of solvent extraction-electrowinning method for, 25:57523 (ORNL-4677)

ORGANISMS
- radioinduced injuries in, evaluation of biochemical indicators of, 25:58126

ORNL HIGH-FLUX ISOTOPE REACTOR
- coolant boiling in, performance of neutron noise and acoustic noise methods for detection of, 25:60181
- fuel elements for, fabrication specifications for, 25:58349 (ORNL-4713)
- radiation targets from, processing at TRU to recover transuranium elements from, 25:57524 (ORNL-TM-3343)

ORNL ISOCHRONOUS CYCLOTRON
- experimental facilities at, computer system for compressed storage of data from, 25:59667
- experimental facilities at, description of system for multiparameter pulse height-analysis by repeated use of single fast ADC, 25:59668

OSMIUM
- abundance on surfaces of peculiar A stars, (E/T), 25:58462
- proton bombardment of, production of radioactive rhenium isotopes by, 25:57480 (JINR-P6-5955)

OSMIUM ISOTOPES Os-190
- neutron inelastic scattering at 14.8 MeV, cross sections and gamma spectra from, (E), 25:59797

OSTEICHTHYES
- Platypoecilus maculatus, radioinduced mutations for macromelanophores in, synergistic effects of hybridization on x, 25:57957

OXYGEN
- content in loop sodium, monitoring of, 25:58166(R) (AI-AEC-12980)
- determination in antimony, gallium arsenide, molybdenum, niobium, and titanium by 14-MeV neutron activation and γ spectrometry, 25:57376
- determination in beryllium by γ activation, nondestructive, 25:57385
- determination in irradiated ceramic fuels, method for, 25:58344(R) (LA-4693)
- determination in liquid sodium, development of on-line meter for, 25:60058(R) (ANL-7817)
- determination in loop sodium, development of meter for, 25:58163(R) (AI-AEC-12859)
- determination in presence of fission products by neutron activation, automated system for, 25:57390
- determination in ruthenium by vacuum fusion method, 25:57329
- deuterium-hydride scattering by molecular, velocity dependence of total effective cross sections for, 25:58782
- deuterium-molecule scattering by molecular, velocity dependence of total effective cross sections for, 25:58782
- diffusion in praseodymium oxide, (E/T), 25:58372
- diffusion in zirconium and zirconium dioxide, Wagner's theory on, 25:58254
- diffusion in zirconium oxide, effects of pressure on, 25:58370
- diffusion through carbon or vanadium pentoxide layers, effects of electric field on, 25:58383
- effects of interstitial, on oxidation resistance of niobium, 25:58172
- effects on γ and x radioinduced mutations in bacteriophage phi X174, 25:57971
- effects on RBE of helium ions for effects on intestinal and spleen colony formation and survival of mice, 25:57997 (LBL-314)
- effects on somatic crossing over in X chromosomes of Drosophila, 25:57959
- electron reactions at 10, 15, and 20 eV with molecular, differential cross sections for excitation in, (E), 25:58732
- electron reactions at 15 eV with molecular, production of oxygen ions (O^-) by dissociative attachment in, (E), 25:58730
- electron reactions at 60 eV with molecular, production of excited oxygen ions (O^+) in, (E), 25:58763
- electron reactions up to 300 eV with molecular, cross sections for ultraviolet emission produced by dissociative excitation in, (E), 25:58758
- electron reactions up to 350 eV with molecular, cross section for production of O I 1300-A multiplet by dissociative excitation in, (E), 25:58728
- electron reactions with molecular, K--LL Auger spectra from, (E), 25:58736
- helium-atom scattering by molecular, velocity dependence of total effective cross sections for, 25:58782
- helium-ion reactions at 100 eV to 4 keV with molecular, energy losses and energy-level transitions in, (E), 25:58753
- hydrogen-ion (H_2^+) reactions at 100 eV to 4 keV with molecular, energy losses and energy-level transitions in, (E), 25:58753
- interactions with hydrogen in interstellar medium, cross sections for transitions of fine structure components of, (E/T), 25:58623
- iodine-ion (I^-) reactions with molecular, effects of thermal motion of molecules on charge exchange in, (T), 25:58752
- iodine-ion reactions at 12 MeV with molecular, electron-capture and -loss cross sections for, (E), 25:58768
- oxygen-ion (O^-) reactions with molecular, effects of thermal motion of molecules on charge exchange in, (T), 25:58752
- proton reactions at 100 eV to 4 keV with molecular, energy losses and energy-level transitions in, (E), 25:58753
- removal from materials during radiosterilization, method for, 25:57625(P)
- sorption on tungsten (100) surfaces at 20 to 1000°C, 25:58226
- spectral lines in Orion Nebula due to, (E), 25:58513
- spectral morphology of 6300-A, in F-region nightglow, (E/T), 25:58884

OXYGEN IONS
- effects on subsequent valence distribution of sulfur-35 ion implanted in sodium chloride crystals, 25:57503
- electron reactions up to 1 keV with O^{2+}, cross sections for ionization in, (E), 25:58774
- emission spectra of, in solar corona, (E), 25:58621
- reactions with celluloid films of multiply charged, film-thickness dependence of cross sections for electron capture and loss in, (E), 25:58695
- spectral emission line intensities of, in solar transition region, (E), 25:58599
- x-ray spectra of solar, (E), 25:58583

OXYGEN IONS (O^+)
- density in F-region nightglow, (E/T), 25:58884
- electron reactions up to 1 keV with, cross sections for ionization in, (E), 25:58774
- reactions with argon and krypton at 10 to 170 eV, effects of excited states on charge exchange in, (E), 25:58763

- OXYGEN IONS (O^-)
  - reactions with oxygen molecules, effects of thermal motion of molecules on charge exchange in, (T), 25:58752
- OXYGEN IONS (O_2^+)
  - density in F-region nightglow, (E/T), 25:58884
- OXYGEN ISOTOPES O-16
  - binding and single-particle energies of, RPA calculation using self-consistent starting energies and higher-order corrections in Goldstone expansion, (T), 25:59723
  - energy levels from electron inelastic scattering, model analysis of, (E/T), 25:59736
  - energy levels of, variational calculation using α-particle model, (T), 25:59726
  - energy-level transitions in π-mesic atoms of, cascade processes and x-ray emission in, (T), 25:58724
  - meson reactions (π^+,2p) at 70 MeV, excitation spectra for, (E), 25:59709 (LA-DC-12389)
  - meson reactions (π^+,p) at 70 MeV, excitation energy spectra and upper limits for cross sections for, (E), 25:59710 (LA-DC-12781)
  - production in stars from simple helium burning, (E), 25:58508
  - proton elastic scattering by, effective cross sections for, (T), 25:59509
  - reactions (O-16,α) with carbon-12 at 28.9 MeV, α-γ angular correlations from, (E), 25:59767
  - reactions (O-16,p) with carbon-12 at 36 and 60 MeV, angular distributions and spectra from, (E), 25:59714
  - reactions (O-16,p) with carbon-12, p-γ angular correlations from, (E), 25:59761
  - scattering by iridium-191 at 25 to 65 MeV with Coulomb excitation, gamma spectra from inelastic, (E), 25:59805
  - scattering by lead-207 at 70 MeV with Coulomb excitation, gamma spectra from inelastic, 25:59804
- OXYGEN ISOTOPES O-17
  - alpha reactions (α,n) at 1 to 5.5 MeV, excitation functions and Hauser--Feshbach calculations of spectra from, (T), 25:59708 (BNWL-B-109)
  - separation from heavy water, design and operation of countercurrent distillation facility for, 25:57675
  - separation from plutonium-238 oxide, gas phase-packed bed method for, 25:57655 (MLM-1844)
- OXYGEN ISOTOPES O-18
  - alpha reactions (α,n) at 1 to 5.5 MeV, excitation functions and Hauser--Feshbach calculations of spectra from, (T), 25:59708 (BNWL-B-109)
  - separation from heavy water, design and operation of countercurrent distillation facility for, 25:57675
  - separation from plutonium-238 oxide, gas phase-packed bed method for, 25:57655 (MLM-1844)
  - use as tracer for studies of oxygen diffusion in zirconium oxide, 25:58370
- OXYGEN SYSTEMS
  - O--Pu--U, phase studies of, 25:58409
  - O--Sc--V, phase studies at 1000 to 1500°C, 25:58401
- OYSTER CREEK POWER REACTOR, UNIT 1
  - protection system for, failure of isolation condenser steam line break sensor relays for, 25:59909 (DOCKET-50219-149)
- OZONE
  - production in BNL chemonuclear loop, efficiency of, 25:57610 (BNL-50293)

P

- PACIFIC OCEAN
  - iron deposits in East Pacific Rise of, thorium and uranium isotopic composition of, 25:57585
  - sediments in East Pacific Rise of, thorium and uranium isotopic composition of, 25:57585
- PACKAGING
  - regulations for hazardous materials, US Dept. of Transportation, 25:57710
- PAINTS
  - analysis by neutron activation, 25:57373
- PALLADIUM
  - preparation of radiation targets of, by argon ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
  - radiation effects on catalytic activity of, in hydrogenation of butynediol, neutron, 25:57448
  - separation from ruthenium and rhodium by coprecipitation with ferric hydroxide, 25:57552
- PALLADIUM ALLOYS AND SYSTEMS
  - Au--Pd--Te, superconductivity in simple cubic intermetallic (Au/sub 1-x/Pd/sub x/)Te_2, 25:58928 (CALT-822-37)
- PALLADIUM ISOTOPES Pd-108
  - neutron reactions (n,2n) at 14.8 MeV, cross sections and gamma spectra from, (E), 25:59797
- PALLADIUM ISOTOPES Pd-110
  - neutron reactions (n,2n) at 14.8 MeV, cross sections and gamma spectra from, (E), 25:59797
- PANCREAS
  - scintigraphy using selenium-75-labeled methionine with colloidal gold-198 liver subtraction by means of television reproduction, 25:58059
  - scintigraphy using selenium-75-labeled selenomethionine, patient positioning and preparation for, 25:58061
- PAPER
  - analysis by neutron activation for identification, 25:57374
- PARTICLE TRACKS
  - formation in mixtures of immiscible liquids, 25:57727
- PARTICLES
  - content and size in French uranium mine air, (E), 25:57564
  - ratio of neutral, to charged particles at altitudes of 800 gm/cm^2, (E), 25:58834
  - size distribution of aerosol submicron, classification using cascade impactors, 25:57573 (ORNL-4226)
  - size of, study of x-radiometric methods for determining, 25:57300 (ORO-3847-2)
- PEACH BOTTOM POWER REACTOR, UNIT 2
  - construction of, request for not suspending permit for, 25:59959 (DOCKET-50277-24)
- PEACH BOTTOM POWER REACTOR, UNIT 3
  - construction of, request for not suspending permit for, 25:59959 (DOCKET-50277-24)
- PENETRANT TESTING
  - method for reactor welded joints, 25:57680 (ORNL-TM-3561)
- 1,3-PENTADIENE
  - effects on γ-radioinduced polymerization of styrene in carbon tetrachloride or hexachlorobutadiene solutions, 25:57454
- PENTANE
  - radiolysis of aqueous solutions of, absorption spectral studies of species from electron pulse, 25:57458(R) (COO-1116-17)
  - radiolysis of oxygenated or pure, absorption spectral studies of species from electron pulse, 25:57458(R) (COO-1116-17)
- PENTANE, 2-METHYL-
  - yields from γ radiolysis of gaseous ethylene in presence of 2-methylpropene, 25:57474
- PENTANE, 3-METHYL-
  - radioinduced luminescence of glasses of, containing olefins, γ, 25:57463
  - yields from γ radiolysis of gaseous ethylene in presence of 2-methylpropene, 25:57474
- 2,4-PENTANEDIONE
  - complexes with chromium, radiation effects on, study of thermal annealing mechanisms in neutron, 25:57496
  - complexes with chromium, radioinduced transfer in chromium-51-doped, neutron, 25:57496
  - complexes with chromium, thermal transfer or exchange in chromium-51-doped, 25:57496
  - complexes with platinum, radiation effects on, isotope effects on reactions of recoils from neutron, 25:57489
- PEOPLE'S DEMOCRATIC REPUBLIC OF GERMANY
  - strontium-90 content of plants and soils in, from 1960 through 1963, effects of fallout from nuclear weapons tests on, 25:57986
- PERCHLORIC ACID
  - analysis of analytical grade, for impurities by neutron activation, 25:57379
- PERIODATES
  - radiolysis of aqueous solutions of, study of transient species in electron pulse, 25:57466
- PERSONNEL
  - deoxycytidinuria incidence among uranium mining, role of age in, 25:58145
  - health hazards to, in storage center for radioactive waste at Hague, 25:57978
  - radiation dosimetry methods for, at Boris Kidric Institute, 25:58018
  - radiation effects on results of thromboelastographic examinations among uranium mining, chronic, 25:58144
  - safety regulations for nuclear, in Hungary, evaluation of, 25:58027
  - training of power reactor, Rheinsberg school for, 25:59916
- PERTURBATION THEORY
  - use of exchange, for molecular excited states, problems in, 25:58702
  - use of Rayleigh--Schroedinger, in hydrogen-atom problem, reasons for failure in, 25:58811
  - vertex parts in, algorithms for γ-algebra of electromagnetic form factors for computer programs for evaluating high-order, 25:59360
- PETROLEUM
  - radiolysis of, production of new products by, 25:57478
- PHAGOCYTOSIS
  - uranium oxide effects on, from rat lung cell, 25:57923
- PHANTOMS
  - development of laminated lucite plate human lung, for study of inhaled plutonium-239 distribution, 25:57998 (NIRS-Pu-8)
  - dose distribution measurements at bone--tissue interfaces in, extrapolation ionization detector for, 25:57851
  - radiation dosimetry in human, idodose curves for whole-body γ and x, 25:58004
- PHARMACEUTICALS
  - analysis of radio-, review on, 25:57350
  - radiation effects on sensitivity of man to, 25:58142
- PHENIX FAST REACTOR
  - boilers for, design problems with, 25:60077
  - control system for, 25:60049

XUM

  design characteristics of, 25:60039
  electrical systems for, 25:60049
  fuel elements for, 25:60085
  heat exchangers for, design problems with intermediate, 25:60077
  instrumentation for, 25:60049
  loading machine for, 25:60087
  physics measurements for, 25:60039
  pumps for, design problems with primary liquid sodium, 25:60077
  remote handling equipment for, 25:60087
  site for, preparation and excavation of, 25:60025
  structures for, construction of foundation, 25:60025
PHONONS
  Boltzmann transport equation for gas of, derivation of hydrodynamics from, 25:59215
  interactions in solids and liquid helium, (T), 25:59204
PHOSPHITES
  effects on chemical state of recoil phosphorus-32 from neutron-irradiated tripolyphosphate hexahydrate, 25:57495
PHOSPHOLIPASE A
  radiation effects on activity in lysosomes, microsomes, and mitochondria in Sticker sarcoma of dogs, γ, 25:57940
PHOSPHONIC ACID, ETHYLENEDI-, DIBUTYL ESTER
  solvent properties for europium from sodium perchlorate solutions, 25:57544
PHOSPHORIC ACID, BIS(2-ETHYLHEXYL) ESTER
  solvent properties for europium, neodymium, and samarium from aqueous chloride solution, 25:57543
PHOSPHORIC ACID, TRIBUTYL ESTER
  solvent properties of, 25:57557
PHOSPHORUS
  radiation effects on metabolism in pea and wheat plants and in first and second filial generations, γ, 25:57941
PHOSPHORUS IONS
  implantation in silicon for use as charged-particle detectors, 25:57749
  ranges and stragglings in silicon at 20 to 400 keV, calculations of, 25:59116
PHOSPHORUS ISOTOPES P-30
  energy levels at 1.453 and 1.974 MeV, lifetimes for, (E), 25:59771
  energy-level scheme from silicon-29 (p,γ) reactions, (E), 25:59760
PHOSPHORUS ISOTOPES P-31
  neutron elastic and inelastic scattering at 7.96 and 9.05 MeV, cross sections for, (E/T), 25:59770
  nuclear magnetic resonance in uranium monophosphide, 25:59189
  photon reactions (γ,n) at 21.5 and 25.5 MeV, analysis for isospin effect in, (E/T), 25:59765
PHOSPHORUS ISOTOPES P-32
  evaluation for scanning human mammary glands for localization of neoplasms, 25:58051
  preparation of applicators of, by sorption on Anex foil Zerolith FF, 25:57500
  radiation effects on oxidation state of recoil, from neutron-irradiated tripolyphosphate hexahydrate, 25:57495
  transport between oats to vetch, 25:57950
  uptake by bone marrow, liver, and spleen of x-irradiated rats, effects of bone marrow transplants on, 25:58123
  uptake by leaves and roots of oats and vetch, 25:57950
  uptake by melanomas in human eyes, diagnostic test using, 25:58063
  uptake by pure and mixed stands of buckwheat and lupine, comparison of, 25:57949
PHOTOGRAPHIC FILM
  performance of Polaroid Types 52 and 57, in neutron radiography, 25:57691
PHOTOMETRY
  calibrations of uvhyβ and gnkmf systems, (E), 25:58480
PHOTONS
  coupling to rho, Veneziano-type representations for, (T), 25:59352
  coupling to vector mesons, Veneziano-type representations for, (T), 25:59352
  exchange contribution of two, to $e^- + N \rightarrow e^- + N$ and $e^+ + N \rightarrow e^+ + N$ interactions at high energies and low momentum transfers, Compton scattering cross sections for, (T), 25:59372
  fission reactions with heavy nuclei at 0.1 to 5 GeV, giant resonance in yields and integral cross sections for, (E), 25:59794
  interaction $\gamma + N \rightarrow \pi^0 + N$, PCAC hypothesis from s-wave threshold amplitudes of, (E/T), 25:59373
  interactions $e + \gamma$ in inelastic $e + e$ interactions, hadron production in deep inelastic, (T), 25:59333 (JINR-E2-6036)
  interactions $\gamma + d \rightarrow$ eta $+ d$, amplitudes with anomalous thresholds for ω exchange and S_{11} contributions to, (T), 25:59514
  interactions $\gamma + e \rightarrow \gamma\ (2\gamma) + e$ in constant electromagnetic field, spectral and angular distributions for Compton and induced Compton, (T), 25:59368
  interactions $\gamma + e$ with electron beams in crystals, anomalous transmission in, (T), 25:59228
  interactions $\gamma + \gamma \rightarrow 3\pi$, relation between amplitudes for $e^+ + e^- \rightarrow 3\pi$, $\pi^0 \rightarrow 2\gamma$, and, 25:59357
  interactions $\gamma + \gamma$ in colliding beams, differential cross sections for hadron production in deep inelastic $e + e$ interactions from total cross sections for hadron production in virtual, (T), 25:59371
  interactions $\gamma + n \rightarrow \gamma + n$, quark model extension for total and differential cross sections for, (T), 25:59378
  interactions $\gamma + N \rightarrow \pi + N$, vector meson dominance of k^2 dispersion relation for invariant amplitudes for π production in, (T), 25:59351
  interactions $\gamma + n \rightarrow \pi^0 + n$ at 4 GeV, cross sections relative to $\gamma + p \rightarrow \pi^0 + p$ interactions, (E), 25:59243
  interactions $\gamma + n \rightarrow$ rho$^-$ $+ p$, rho-exchange contribution to differential cross sections for, 25:59385
  interactions $\gamma + N$, classical charge-symmetric field theory for cross sections for scalar meson production in, (T), 25:59338
  interactions $\gamma + N$, field theoretical basis for weak-interaction theory for, (t), 25:59397
  interactions $\gamma + N$, nonleading Regge behavior and fixed poles with polynomial residues in Compton, 25:59381
  interactions $\gamma + p \rightarrow$ eta $+ p$ below 1 GeV/c, $S_{11}(1530)$ production in, (T), 25:59514
  interactions $\gamma + p \rightarrow \gamma + p$ in deep inelastic $e + p$ current interactions, field theory for amplitudes of Compton, (T), 25:59363
  interactions $\gamma + p \rightarrow \gamma + p$, quark model extension for total and differential cross sections for, (T), 25:59378
  interactions $\gamma + p \rightarrow \pi^0 + p$ at 4 GeV, cross sections relative to $\gamma + n \rightarrow \pi^0 + n$ interactions, (E), 25:59243
  interactions $\gamma + p \rightarrow \pi^+ + n$, pseudomodel predictions for differential cross sections for polarized, 25:59362
  interactions $\gamma + p$ at high energies, Regge pole model for total cross sections of Compton, 25:59340
  interactions $\gamma + \pi \rightarrow \pi + \pi$, hard-meson current algebra and PCAC model for γ--3π coupling constant and form factor for, 25:59382
  interactions with hadrons, hadron electrodynamics in resonance model for absorption cross sections for, 25:59386
  interactions with hadrons, parity rule and helicity conservation in rho^0 production in, 25:59384
  motion in refracting medium, (T), 25:59325
  production in backward $e^+ + e^- \rightarrow e^+ + e^- + m\gamma$ interactions at high energies, double-logarithmic approximation for cross sections for, (T), 25:59374
  production in backward $e^+ + e^-$ interactions at high energies, integral equation for cross sections from partial waves with multi-Regge poles for amplitudes of, (T), 25:59369
  production in $N + N \rightarrow N + N + \gamma$ interactions, review of, (E), 25:59241 (CONF-710915-2)
  production in neutrino annihilation of polarized leptons, angular distributions and spectra for, (T), 25:59402
  production in nuclear reactions, ENDF formats and procedures for storage of data on, (T), 25:59838 (LA-4549)
  properties of photon tachyons in disappearing Fresnel wave, strong correlation between Cherenkov effect and, (T), 25:59573
  reactions (γ,α) on beryllium, carbon, and cellophane, pulse-height spectra from, (E), 25:59734
  reactions (γ,d) with helium-4, dispersive calculation using Omnes--Muskhelishvili equation of cross sections for, (T), 25:59698
  reactions (γ,e^+e^-) with nuclei, vector dominance model for rho--ω mixing in, 25:59364
  reactions (γ,n) with lead-207 and -208 and iron-56 and -57 at threshold, review of cross sections and photon doorways for, (E), 25:59784 (UCRL-73336)
  reactions with aluminum, carbon, copper, and lead at 560 MeV, emulsion study of dependence on atomic weight for yields of π^+ and π^- from, (E), 25:59248
  reactions with hydrogen atoms, calculation of radial transition matrix elements for, 25:58770
  reactions with nuclei, ENDF formats and procedures for storage of data on, (T), 25:59838 (LA-4549)
  reactions with various metals, secondary electron emission from, (E/T), 25:59107
  scattering by carbon, deuterium, and helium-4, analysis for double scattering and glory effects in Compton, 25:59703
PHOTOSPHERE
  brightness temperatures in, (E), 25:58596
  electric conductivity in faculae, (E/T), 25:58588
  electric conductivity in, (E/T), 25:58588
  facula-to-photosphere contrast, effects of scattered light on, (T), 25:58587
  spectra of, K-line profiles in, (E), 25:58596
PHYSICAL CHEMISTRY
  research progress on fundamentals of effusion and thermodynamics of materials, 25:57435(R) (COO-1029-39)
PHYSICS
  book: Topics in Modern Physics: A Tribute to Edward U. Condon, 25:58682
  conference on theoretical, Birmingham, England, 6/67, (T), 25:59209
PILGRIM POWER REACTOR
  site for, environmental radiation survey during April to

XUM

  - June 1971, 25:59966 (DOCKET-50293-56)
  - startup of, effects on regional power supply of delay in, 25:59956 (DOCKET-50271-63)
- PILOCARPINE
  - effects on excretion of plutonium-239 by rats, 25:57998 (NIRS-Pu-8)
- PINCH DEVICES
  - plasma losses in high-current, from inverse skin effect, (T), 25:58967
  - plasma properties in dynamic z-, discharge ignition effects on, (E), 25:59015
  - plasma properties in theta-, electron bursts in, (E), 25:59021
- PINCH EFFECT
  - ion distribution function for high-current z-, (E), 25:59024
- 2-PINENE
  - radioinduced polymerization under superdry conditions, γ, 25:57450 (ORO-3667-1)
- PIPE FITTINGS
  - erosion of high-pressure, chromium-50 and cobalt-60 tracer techniques for measuring, 25:57662
- PIPES
  - crack initiation and growth in reactor cooling systems, effects of low-cycle fatigue on, (E), 25:60061(R) (GEAP-10207-24)
  - defects in metal, standard ultrasonic method for detecting longitudinal, 25:57686
  - design and performance of glass, for reactors, 25:58421
  - failure in reactor cooling systems, probability analysis of, 25:60061(R) (GEAP-10207-24)
- PLACENTA
  - scintigraphy for localization of, using metastable indium-113, 25:58060
- PLANETARY NEBULAE
  - helium abundances in, (E/T), 25:58446
  - radio emission from 121, (E), 25:58544
  - spectra of NGC 7662, (E), 25:58516
- PLANETS
  - effects on large-scale distribution of solar activity, (E), 25:58611
  - effects on solar activity, (T), 25:58570 (N-71-14166)
  - formation from charged bodies ejected from Sun, (T), 25:58591
  - formation of, floccule theory of, (T), 25:58586
  - orbits of, torsion effects on perihelion motion of, (T), 25:59605
- PLANTS
  - analysis for cesium-137 by radiochemical isolation and γ spectrometry or beta detection, 25:57355
  - analysis of standard, for selenium by neutron activation, 25:57380
  - radiation effects on seeds and cuttings of berry, effects of dose and species on gamma, 25:58151
  - strontium-90 content of agricultural, in East Germany, effects of fallout from nuclear weapons tests on, 25:57986
  - tungsten-181 content in off-site, following Schooner Event, (E), 25:57574 (PNE-524)
- PLASMA
  - atomic metastable densities in helium, neon, and mixed helium--neon, in neutron environment, (E/T), 25:59003
  - bibliography on plasma physics and fusion reactors, 25:58955
  - book: Plasma Physics and Problems of Controlled Thermonuclear Synthesis, 25:58957
  - boundary layer near electrodes, approximation method for calculating, 25:59051
  - boundary sheath near cathode in disturbed, (T), 25:59035
  - collisions in turbulent weakly ionized, cross sections for, (T), 25:59039
  - conductivity in toroidal devices with trapped particles, electric, (T), 25:59046
  - confinement from atomic beam interactions with ECR-heated targets, (T), 25:58969
  - confinement in DECA IIB, equilibrium in, (E), 25:58958 (CEA-CONF-1807)
  - confinement in pinch devices, losses from inverse skin effect, (T), 25:58967
  - confinement in tokamaks and bumpy torus, energy flow and current diffusion in, (T), 25:58961 (CONF-711016-1)
  - confinement in tokamaks, effects of effective electron collision frequency on, (E), 25:58974
  - confinement in toroidal traps using hf electric fields, (E/T), 25:58976
  - confinement in trapped-particle-free stellarators, adiabatic compression of, (T), 25:58964
  - diagnostics in free-burning arcs, spectroscopic, (E/T), 25:58998
  - diagnostics in medium-beta torus JFT-2, microwave interferometric, (E), 25:58979 (JAERI-Memo-4530)
  - diagnostics in tokamaks using alpha particles, current distribution, (T), 25:58980 (JAERI-Memo-4531)
  - diagnostics near boundary of quartz wall, temperature, 25:58985
  - diagnostics of cesium, using hot and cold probes, (E), 25:58986
  - diagnostics of continuum gas, theory of cooled spherical electrostatic probe for, 25:58982
  - diagnostics of magnetized, ion and atom temperature, (E/T), 25:58988
  - diagnostics of turbulent, probe geometry effects on, (E), 25:58983
  - diagnostics of turbulent, using shf wave scattering, (T), 25:58996
  - diagnostics of uranium, spectroscopic, 25:59000
  - diagnostics of, double microfield probe for, (E), 25:58990
  - diagnostics of, electron temperature and recombination coefficients from spectroscopic, (E/T), 25:58993
  - diagnostics of, using particle-loss measurements and beam interactions, 25:58994
  - diagnostics using cylindrical Langmuir probes, voltage--current characteristics in, 25:58999
  - diagnostics using Doppler effect at electron cyclotron frequency, (E), 25:58997
  - diagnostics using double probes, effect of electron and ion drifts on, (T), 25:58981
  - diagnostics using electrostatic probes, potential, (E), 25:58992
  - diagnostics using microwave reflection, methods for, 25:58995
  - diagnostics using open resonator, density, 25:58977(T) (AEC-tr-7271)
  - diagnostics using optical interferometry and holographic techniques, 25:59001
  - dielectric permittivity of weakly ionized, in crossed fields, (T), 25:59050
  - diffusion in closed magnetic traps, effects of charged particle streams on, (T), 25:58975
  - diffusion in multipoles toward conductors and walls, (T), 25:58970
  - electric discharge in, computer simulation of breakdown potential, (E/T), 25:59004
  - electric discharges in low-pressure hydrogen, potential breakdown in, (E), 25:59022
  - electron beam interactions with, Doppler shifts at cyclotron frequency in, (E), 25:58997
  - electron distribution function deformation under influence of large-amplitude wave, (E), 25:59012 (CEA-CONF-1833)
  - electron energy balance equation for positive column, self magnetic fields in, (T), 25:59038
  - expansion of rarefied, in vacuum, (T), 25:59049
  - heating and collisions in, models for simulating, 25:59033
  - heating at ion cyclotron resonance, collisionless, 25:58973
  - heating at second harmonic of electron cyclotron frequency, (E), 25:58971
  - heating by electron beams, effects of magnetic fields on, (E), 25:58972
  - heating by lasers in density range 10^{17} to 10^{19}/cm^3, 25:59054 (MATT-782)
  - heating by lasers, prospects for, 25:59057
  - heating in Heliotron C, ohmic, (E), 25:58963
  - heating in magnetic mirrors, stochastic model of ECR, (T), 25:58968
  - heating in tokamak devices, high-frequency, (T), 25:58966
  - heating in toroidal devices, transit-time magnetic pumping in, 25:58959 (CEA-CONF-1830)
  - heating of deuterium--tritium, by lasers, (T), 25:58965
  - heating of ions by electrostatic ion cyclotron waves, low-loss coupling method for, 25:58962 (IPP-IV-25)
  - heating of laser-produced, at lower hybrid resonance, (E), 25:58960 (CEA-CONF-1831)
  - injection and confinement from atomic beam interactions with ECR-heated targets, (T), 25:58969
  - injection of fast atomic deuterium into high-temperature, penetration of, (T), 25:59030
  - interactions of argon and neon, in pseudo equilibrium with additions, 25:59018
  - ion distribution function for high-current z discharges, (E), 25:59024
  - ion production and loss processes in helium--nitrogen mixtures, (E), 25:59014
  - ionization decay in neon--nitrogen, ion production and loss in, (E), 25:59019
  - ionization in nonequilibrium low-pressure cesium, excited states in, (T), 25:59008
  - ionization levels in cesium, population of, 25:59034
  - ionization levels in low-current helium arc, population of, (E), 25:59017
  - kinetic theory of hydrogeneous, effective potentials for components of, 25:59042
  - kinetic theory of turbulent, quasi-linear approximation for, 25:59027 (IPP-6/94)
  - kinetic theory of warm electron, eigenvalue problems for Lagrangian systems, 25:59052
  - kinetic theory of, integration methods for Vlasov equation for, 25:59040
  - kinetic theory of, polynomial expansion method for problems involving relativistic Maxwellian distribution, 25:59053
  - kinetics of weakly ionized, steady-state charged-particle distribution in, (T), 25:59048
  - motion in hf electromagnetic fields, nonlinear theory of, 25:59037
  - production and heating using lasers, possibilities of, 25:59054 (MATT-782)
  - production of dense, shock wave pre-ionization for theta pinches, 25:59056

XUM

  production of quiescent, in skipping magnetic fields, (E), 25:59055
  production using lasers, review of, 25:59058
  properties in dynamic z-pinch, discharge ignition effects on, (E), 25:59015
  properties in theta-pinch discharges, electron bursts in, (E), 25:59021
  properties of magnetospheric, review of, (E/T), 25:58910
  radiation emission from nonequilibrium, effects of spatial dispersion on cyclotron, (E), 25:59097
  radiation intensity in axisymmetric dense, radial distribution of, (T), 25:59036
  radiations from thermally magnetized, nonlinear harmonic generation by microwaves, (E), 25:59013 (CEA-CONF-1835)
  radiations from, semiclassical calculations of bremsstrahlung power density, 25:59045
  radiative transfer in homogeneous, generalized Newton--Raphson method for excitation and, 25:59041
  relaxation processes in magnetoactive, quasi-linear approximation for collisional, 25:59007
  shock wave evolution in, turbulent electrostatic, (E), 25:59020
  shock wave propagation in, relativistic theory of detonation, 25:59043
  shock wave simulation in, high-Mach-number turbulent magnetosonic, (T), 25:59044
  simulation of, accessibility of exact nonlinear stationary states in water-bag model, 25:59025 (CEA-CONF-1832)
  simulation of, collision and heating in two-dimensional, 25:59033
  spectra line broadening in, Franck--Condon principle for isolated, 25:59032
  spectra of dense helium, contours and intensity of liner in, 25:59016
  spectra of, device for measuring time-resolved profiles of, 25:58989
  spectra of, electron correlations in unified line shapes, (T), 25:59026 (CEA-CONF-1834)
  spectra of, electron temperature and recombination coefficients from, (E/T), 25:58993
  stability criteria for relativistic, in magnetic fields, (T), 25:59064
  stability in external electric fields oscillating near plasma frequency, (T), 25:59067
  stability in positive column discharges, (T), 25:59072
  stability in tokamaks, collisional effects on dissipative, (T), 25:59060 (CEA-CONF-1800)
  stability of high-frequency resonant, (E), 25:59063 (NP-19031)
  stability of inhomogeneous finite-β, ion cyclotron drift, (T), 25:59070
  stability of semi-infinite plane slab, kink and tearing-mode, (T), 25:59068
  stability of two-component anisotropic, electrostatic, (T), 25:59061 (CEA-CONF-1828)
  stability of uniform magnetized, linear theory for, (T), 25:59102
  stability of weakly ionized, unified linear theory for magnetohydrodynamic, 25:59066
  stability of, asymptotic behavior of two-stream, (T), 25:59062 (IPP-6/97)
  stabilization of thin filaments of, dynamic, (T), 25:59071
  temperature difference of ions and electrons in collisional, quasi-linear approximation of, 25:59007
  temperature relaxation in, ion and electron, (T), 25:59028
  theory for tachyon, classical tachyon mechanics for formulation of Maxwell--Vlasov, (T), 25:59556 (IPP-6/95)
  use of high-temperature air, in transpiration cooling of nuclear rocket nozzles, 25:57640 (N-71-22591)
  uses in powder metallurgy, 25:58187(T) (SCL-T-710281)
  viscosity in strong magnetic fields, unified theory for, 25:59029
  wave absorption at upper hybrid frequency, microwave, (E), 25:59091
  wave absorption by cold, boundary effects on, (T), 25:59084 (CEA-CONF-1827)
  wave absorption in cylindrical column of cold magnetized, electromagnetic, (T), 25:59088
  wave buildup in inhomogeneous finite-β, ion cyclotron drift, (T), 25:59070
  wave damping in inhomogeneity of cold collisionless, electromagnetic, (T), 25:59081(T) (AEC-tr-7272)
  wave damping in inhomogeneous, drift-, (T), 25:59103
  wave echoes in, exact test-particle propagator of Lenard--Bernstein equation for, (T), 25:59087
  wave excitation by coupling between transverse and longitudinal fields, electron, 25:59101
  wave excitation by different electron and ion temperatures, low frequency, (T), 25:59069
  wave excitation by grids in collisionless, ion, (E/T), 25:59095
  wave excitation in infinite cylindrical column of, edge effects on magnetoacoustic, (E), 25:59089
  wave interactions in discharge, ion acoustic and ionization, (E/T), 25:59098
  wave interactions in, nonlinear electron, (T), 25:59099
  wave interactions with charged particles in, cyclotron-frequency, (T), 25:59096
  wave interactions with two-component, reflection and transmission of lf Alfven, (T), 25:59093
  wave interactions with, effect on microinstabilities for anisotropic ion temperatures, 25:59083 (CEA-CONF-1826)
  wave propagation at anisotropic pressures, stationary, (T), 25:59085
  wave propagation in inhomogeneous, nonlinear magnetoacoustic, (T), 25:59086
  wave propagation in magnetized, dispersion relations for surface, (T), 25:59092
  wave propagation in magnetized, large-amplitude TM, (T), 25:59094
  wave propagation in multicomponent cold, at angles to magnetic field, (T), 25:59090
  wave propagation in positive column discharges, low-frequency, (T), 25:59072
  wave propagation in uniform magnetized, linear theory of transverse, (T), 25:59102
  wave propagation on inhomogeneous column, surface, (E/T), 25:59100
  wave scattering on turbulent, shf electromagnetic, (T), 25:58996
  wave transformation and emission from beam--plasma discharge, density effects on, (E/T), 25:59104
  wave transformation at upper hybrid resonance, for oblique incidence, (T), 25:59082 (CEA-CONF-1803)
  wave transformation in, coupled equations for electromagnetic, (T), 25:59105
PLASMA ACCELERATORS
  design of mercury electron-bombardment ion thrusters, 25:59011
  ion sources for Hall, high-current hollow cathode, 25:59080
  neutral gas acceleration in rail-type, by shock waves, (T), 25:59031
  properties of toroidal glow discharge, in radial magnetic fields, (E/T), 25:59002
PLASMA JETS
  diagnostics of argon and neon, interferometric determination of temperature, (E), 25:58984
  diagnostics of argon and neon, spectroscopic, 25:58991
  diagnostics using lasers, electron density and temperature, (E/T), 25:58987
  diagnostics using optical methods, ion velocity, 25:58978 (CEA-CONF-1829)
  interactions of, ordinary mode electromagnetic instability in, (T), 25:59065
  stability of colliding, ordinary mode electromagnetic, (T), 25:59065
PLASMAPAUSE
  electron precipitation near, correlation with vlf emissions and plasmapause position, (E/T), 25:58897
  formation of, associated with dynamical processes in ionosphere and magnetosphere, (E/T), 25:58867
  formation of, relation to acceleration and precipitation of outer magnetospheric thermal plasma, (E/T), 25:58909
  magnetic-field measurements near L approximately equal 4, conjugate geomagnetic-noise and coherent-pulsation, (E), 25:58898
  plasma instabilities in magnetospheric, review of, 25:58895
PLASTICS
  reactions of dielectric, with fluorine, 25:57619 (RFP-1739)
  B--plastics, properties of continuous filament reinforced, for use in space vehicles, 25:58422
  graphite--plastics, properties of continuous filament reinforced, for use in space, 25:58422
PLATINUM
  abundance on surfaces of peculiar A stars, (E/T), 25:58462
  complexes with 2,4-pentanedione, radiation effects on reactions of recoils from neutron, 25:57489
  neutron capture by, in acetylacetonate complexes, isotope effects on recoils from, 25:57489
  preparation of radiation targets of, by argon ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
  separation from gold by solvent extraction using triphenylguanidinium chloride, 25:57554
  void formation in, by quenching, 25:58319
PLATINUM ALLOYS AND SYSTEMS
  Cm--Pt, preparation of intermetallic $CmPt_3$, by oxide reduction reactions, 25:57658(R) (ORNL-4723)
  Hf--Pt-base--Rh--Ti--W, hardness of crystallized, effects of annealing at high temperatures on, 25:57658(R) (ORNL-4723)
  Pt-base--Rh--W, compatibility with tungsten at high temperatures, 25:57658(R) (ORNL-4723)
  Pt-base--Rh--W, hardness of crystallized, effects of annealing at high temperature on, 25:57658(R) (ORNL-4723)
PLATINUM ISOTOPES Pt-191
  electron-capture decay of, branching ratios, conversion-electron, gamma, and x-ray spectra, and log-ft and Q values for, (E), 25:59805
  energy levels of, determination of electromagnetic transition probabilities from mean lifetimes of, (E), 25:59776 (FRNC-TH-56)

XUM

PLOWSHARE PROJECT
- bibliography of civil, industrial, and scientific uses for nuclear explosions in, 25:57603 (TID-3522(Rev.9))
- fallout from Schooner Event in, data from off-site environmental monitoring of, 25:57574 (PNE-524)
- field testing system for, data tabulation on economic, equipment, and personnel aspects of, 25:57601 (LMSC-D-177630(Vol.2))

PLUTONIUM
- abundance on surfaces of peculiar A stars, (E/T), 25:58462
- buildup in fast reactor fuels, effects of fuel cycle on, (T), 25:60095(R) (IAEA-R-742-F)
- content of human lungs, multiwire proportional detector for measuring, 25:57773
- criticality of hemispheres and spheres of alpha-phase, equipment and methods for measuring, 25:57718
- deposition as oxide on instrument parts of stainless steel, electrolytic, 25:57440
- determination following thin-layer chromatography, radiometric, 25:57357
- determination in biological samples, radiochemical method for, 25:57998 (NIRS-Pu-8)
- determination in mixed oxide fuels, development of methods for, 25:58344(R) (LA-4693)
- determination in urine, methods used at CNEN for, 25:57347 (RT/PROT-(71)9)
- determination relative to uranium in oxide fuels during fabrication, 25:57507(R) (ANL-7799)
- diffusion of cobalt in, tracer studies of, 25:58212 (NRCN-268)
- disproportionation of tetravalent, in nitric and perchloric acids, chromatographic studies on, 25:57357
- distribution between nitric acid and TBP, effects of valence state on, 25:57357
- fuel cycles for high temperature gas cooled reactors, economics of, 25:60097 (ORNL-TM-3525)
- oxidation and reduction in Purex Process, 25:57507(R) (ANL-7799)
- oxidation of trivalent, in lithium chloride--potassium chloride eutectic, chronopotentiometric study of, 25:57420
- oxidation potential for trivalent--tetravalent, 25:57437
- preparation and properties of heptavalent, 25:57404
- preparation of radiation targets of, methods for, 25:59634 (CONF-711002-, pp 59-69)
- preparation of thick samples of, by powder metallurgy, 25:58181 (CONF-711002-, pp 77-81)
- preparation of thin films of, by electrophoresis and electrospraying, 25:58183 (CONF-711002-, pp 160-5)
- production in Federal Republic of Germany, 25:57666
- production in JRR-1, measurement of, 25:57320
- purification by continuous ion exchange, control system for operation of equipment in, 25:57510 (ARH-SA-82)
- reactions with chromium and arsenic, 25:57413
- reactions with chromium in presence of acetaldehyde and arsenite, 25:57411
- recycle in pressurized heavy water power reactor fuels, analysis of optimum economic, 25:60092 (AECL-3910)
- separation from fast breeder fuels by Purex Process solvent extraction, 25:57518(T) (EURFNR-888)
- separation from incinerator ash, evaluation of methods for, 25:57525 (RFP-1723)
- separation from neptunium and promethium by ion exchange chromatography on zirconium phosphate, 25:57550
- separation from other actinides by paper or thin-layer chromatography, 25:57553
- separation from other cations by solvent extraction using TBP, 25:57357
- separation from spent LMFBR fuels by solvent extraction, performance of centrifugal contactor in, 25:57507(R) (ANL-7799)
- separation from spent LMFBR fuels, development of mixer-settler for, 25:57508 (ANL-7810)
- separation of berkelium from, by sorption on zirconium phosphate--silicate, 25:57530
- separation of various valence forms of, by paper or thin-layer chromatography, 25:57553
- spectra of hexavalent, in dilute sodium carbonate solutions, absorption, 25:57403
- utilization in thermal reactor fuels, projections of, 25:60249

PLUTONIUM ALLOYS AND SYSTEMS
- diffusion of cobalt in, tracer studies of, 25:58212 (NRCN-268)
- O--Pu--U, phase studies of, 25:58409
- Pu--Ru, thermodynamic properties of intermetallic $PuRu_2$, at 913 to 1076°K, measurement using emf cells, 25:58211 (LA-4758)

PLUTONIUM CARBIDES
- alpha reactions (α,n) in Hauser--Feshbach calculation of neutron spectra for, (T), 25:59708 (BNWL-B-109)
- PuC--UC, hardness of fuels of, at 400 to 500°C, 25:58344(R) (LA-4693)
- PuC--UC, phase studies of, 25:58344(R) (LA-4693)
- PuC--UC, preparation of fuels of, method for, 25:58163(R) (AI-AEC-12859)
- PuC--UC, preparation of tungsten-modified, by carbothermic reduction of mixed component oxides, 25:58365 (AI-AEC-12983)
- PuC--UC, radiation effects on encapsulated fuels of, at high burnups, in-pile, 25:58344(R) (LA-4693)

PLUTONIUM ISOTOPES
- cross section measurements of, nondestructive and destructive methods of analysis used in fabrication of targets for, 25:57345 (CONF-711002-, pp 293-306)
- hazards for man, review, 25:57998 (NIRS-Pu-8)

PLUTONIUM ISOTOPES Pu-238
- decay scheme, 25:57998 (NIRS-Pu-8)
- design of heat source of, for cardiac pacemaker, 25:57668(P)
- fabrication and testing of heat sources of, for use in implantable cardiac pacemaker, 25:57657(R) (NUMEC-4189-6)
- performance as heat source in thermionic converters, analysis of systems, 25:57656 (N-71-18512)
- preparation of aluminum-clad foils of, method for, 25:58180 (CONF-711002-, pp 70-6)
- use as heat source in implantable cardiac pacemaker, 25:57669

PLUTONIUM ISOTOPES Pu-239
- content of human lungs, development of large proportional and scintillation detectors for measurement of, 25:57998 (NIRS-Pu-8)
- content of human puncture wounds, design of collimated alpha detector for measurement of, 25:57998 (NIRS-Pu-8)
- decay scheme, 25:57998 (NIRS-Pu-8)
- distribution in lung tissues following inhalation, development of phantom for studies of, 25:57998 (NIRS-Pu-8)
- distribution in mice and rats, whole-body autoradiographic method for measurement of, 25:57998 (NIRS-Pu-8)
- effects on incidence of osteosarcomas in beagle dogs following intravenous injection, 25:57918
- excretion and retention time in man following acute or chronic intake, method for calculation of, 25:57919
- excretion by rats, effects of dehydrocholic acid, DTPA, and pilocarpine on enhancement of, 25:57998 (NIRS-Pu-8)
- inhalation of insoluble, radiation dose to lungs and pulmonary lymph nodes of man following acute or chronic, 25:58001 (UCRL-73388)
- monitoring in air, design of combined detector and sampler for, 25:57998 (NIRS-Pu-8)
- neutron capture-to-fission up to 15 keV, review of data on, 25:59812
- neutron fission at thermal to 2 MeV energies, energy dependence of prompt neutron yield from, (E), 25:59810
- neutron fission of, absolute cross section for thermal, (E), 25:59777 (IFA-NR-33)
- preparation of aluminum-clad foils of, method for, 25:58180 (CONF-711002-, pp 70-6)

PLUTONIUM ISOTOPES Pu-240
- decay scheme, 25:57998 (NIRS-Pu-8)
- preparation of aluminum-clad foils of, method for, 25:58180 (CONF-711002-, pp 70-6)

PLUTONIUM ISOTOPES Pu-241
- decay scheme, 25:57998 (NIRS-Pu-8)
- preparation of aluminum-clad foils of, method for, 25:58180 (CONF-711002-, pp 70-6)

PLUTONIUM ISOTOPES Pu-242
- decay scheme, 25:57998 (NIRS-Pu-8)
- preparation of aluminum-clad foils of, method for, 25:58180 (CONF-711002-, pp 70-6)

PLUTONIUM NITRATES
- $Pu(NO_3)_4$--$UO_2(NO_3)_2$, processing at West Valley Processing Plant, safety evaluations for, 25:57514 (DOCKET-50201-89)

PLUTONIUM OXIDES PuO_2
- aging experiments on pellets of, flowsheets for, 25:57658(R) (ORNL-4723)
- alpha reactions (α,n) in Hauser--Feshbach calculation of neutron spectra for, (T), 25:59708 (BNWL-B-109)
- preparation from plutonium nitrate, fluid-bed process for, 25:57507(R) (ANL-7799)
- preparation of targets of, by vacuum evaporation, 25:59638 (CONF-711002-, pp 116-21)
- production of oxygen-17 and -18 depleted, gas phase-packed bed method for, 25:57655 (MLM-1844)
- Mo--PuO_2, aging experiments on curium oxide-doped cermet pellets of, flowsheets for, 25:57658(R) (ORNL-4723)
- Mo--PuO_2--ThO_2, etching of sintered, for optical microcopy, method for, 25:58354
- PuO_2--ThO_2, etching of sintered, for optical microscopy, method for, 25:58354
- PuO_2--ThO_2, metallography of molybdenum-coated pressed pellets of, 25:58398
- PuO_2--UO_2, analysis of fuels of, for plutonium and uranium, methods for, 25:58344(R) (LA-4693)
- PuO_2--UO_2, melting heat rating of, (E), 25:60243
- PuO_2--UO_2, microstructure of fuel pellets of, for fast flux irradiation studies, 25:58397
- PuO_2--UO_2, plutonium segregation in, neutron radiographic method for detection of, 25:57698
- PuO_2--UO_2, preparation of fuels from reprocessed, CNEN and SNAM methods for, 25:58351 (RT/ING-(70)30)
- PuO_2--UO_2, properties of stainless steel-clad fuel pins of, for 1000 MW(e) helium-cooled breeder reactor, mechanical and thermal, 25:58410 (BLG-456)
- PuO_2--UO_2, radiation effects on enthalpy of fuels of, in-

XUM

- pile, 25:58344(R) (LA-4693)
  - PuO_2--UO_2, radioautography of irradiated fuel elements of, method for hot cell, 25:57693
  - PuO_2--UO_2, radioinduced tritium production in, relations of burnup with fast neutron, 25:58344(R) (LA-4693)
  - PuO_2--UO_2--WO_3, reduction to tungsten-modified carbide fuels, carbothermic, 25:58365 (AI-AEC-12983)
- PLUTONIUM PEROXIDES
  - preparation and properties of pentavalent, 25:57400
- POINT BEACH POWER REACTOR, UNIT 1
  - operation of, request for not suspending license for, 25:59954 (DOCKET-50266-56)
- POINT BEACH POWER REACTOR, UNIT 2
  - emergency core cooling system for, performance evaluation for small break conditions, 25:59968 (DOCKET-50301-41)
- POLONIUM
  - electromigration behavior of, in CDTA and EDTA, 25:57520 (JINR-E6-5552)
- POLONIUM ISOTOPES Po-210
  - determination in urine, methods used at CNEN for, 25:57347 (RT/PROT-(71)9)
  - energy levels from lead-208 (α,2n) reactions, core-excited, (E), 25:59817
- POLONIUM ISOTOPES Po-218
  - content in particles in French uranium mine air, (E), 25:57564
- POLYPHOSPHATES
  - radiation effects on tripolyphosphate hexahydrate, effects of radical scavengers on yields from reactor, 25:57495
- POPULATIONS
  - radiation hazards to human, from artificial and natural sources, 25:57994
- POSITRON CAMERAS
  - development of multiple proportional detector, 25:57774
- POSITRONS
  - annihilation in gases, time dependence of, (E), 25:58725
  - annihilation in iodine at 80 to 180 keV, cross sections and spectra from single-quantum, (E), 25:58723
  - emission from mica and polyethylene absorbers, 25:58681
  - emission in $W^+ \to e^+ + \nu$ decay, angular and momentum distributions for, (T), 25:59413
  - interactions $e^+ + e^- \to 3\pi$, relation between amplitudes for $\pi^0 \to 2\gamma$, $\gamma + \gamma \to 3\pi$, and, 25:59357
  - interactions $e^+ + e^- \to e^+ + e^- + \gamma + \gamma$, cross sections for π^0, eta, and eta' production in, 25:59389
  - interactions $e^+ + e^- \to e^+ + e^- + \gamma + \gamma$, proposal for experimental study of $\pi^0\gamma\gamma$, eta $\gamma\gamma$, and $X^0\gamma\gamma$ vertices from, 25:59253
  - interactions $e^+ + e^- \to e^+ + e^- + m\gamma$ at high energies, double-logarithmic approximation for bremsstrahlung cross sections for backward, (T), 25:59374
  - interactions $e^+ + e^- \to eta^0(X^0) + \gamma$ in vector meson region, vector dominance model with linear and quadratic mixing of eta and X^0 for cross sections for, (T), 25:59377
  - interactions $e^+ + e^- \to N +$ anti N, production of S(1727), S(1414), d(1382), and d(1855) in colliding-beam, (T), 25:59358
  - interactions $e^+ + e^- \to p +$ anti p, scaling law for proton form factors for, 25:59361
  - interactions $e^+ + e^- \to p +$ anything, hadron electrodynamics in resonance model for, 25:59386
  - interactions $e^+ + e^- \to$ phi $\to \pi^- + \pi^+ + \gamma$, conformal symmetry for, 25:59542
  - interactions $e^+ + e^- \to \pi^0 + \gamma$ in vector meson region, vector dominance model for cross sections for, (T), 25:59377
  - interactions $e^+ + e^-$ at 1.4 to 2.4 GeV, analysis of elastic, (E), 25:59250
  - interactions $e^+ + e^-$ at 1.4 to 2.4 GeV, cross sections for multiple particle production in, (E), 25:59251
  - interactions $e^+ + e^-$ at high energies, integral equation for cross sections from partial waves with multi-Regge poles for bremsstrahlung amplitudes in backward, (T), 25:59369
  - interactions $e^+ + e^-$ in colliding beams, contribution to total cross section from bremsstrahlung mechanism for differential cross section for hadron production in, (T), 25:59375
  - interactions $e^+ + e^-$ in colliding beams, differential cross sections for hadron production in deep inelastic e + e interactions from, (T), 25:59371
  - interactions $e^+ + e^-$ in crossed beams, Landau--Lifshitz process for cross sections for hadron production in, (T), 25:59334 (LNF-71/14)
  - interactions $e^+ + e^-$, cross section for heavy lepton production in, (T), 25:59390
  - interactions $e^+ + e^-$, Regge-pole-theory prediction of scaling in hadron production in, (T), 25:59376
  - interactions $e^+ + e^-$, total cross sections for W and e^+ production in colliding-beam, 25:59383
  - interactions $e^+ + N \to e^+ + N$ at high energies and low momentum transfers, Compton scattering cross sections for two-photon-exchange contribution to, (T), 25:59372
  - production in neutrino reactions with iron, angular and momentum distributions for, (T), 25:59415
  - production in neutrino reactions with nuclei, angular and momentum distributions for, (T), 25:59415
  - reactions with hydrogen atoms, theory of generalized variational bounds for positronium formation in, 25:58755
  - scattering by nuclei, radiative corrections for elastic, 25:59880
- POTASSIUM
  - determination in Roanoke River water by neutron activation and γ spectrometry, 25:57395
  - determination in solid rocket propellants by neutron activation and gamma spectroscopy, 25:57384
  - determination of extracellular, in man, radioisotope dilution method for, 25:57924
  - effects on complexonometric determination of rare earths, 25:57317
  - electromigration in molten chlorides, 25:57439
- POTASSIUM ACID CARBONATES
  - radioinduced free radicals in single crystals of, at 77°K, ESR study of γ, 25:57471
- POTASSIUM ACID PHOSPHATES
  - deuterium isotopic effect on ferroelectric properties and Curie temperature of crystals of, (T), 25:59196
- POTASSIUM AMIDES
  - H_2--KNH_2, radiolysis of aqueous solutions of, production of long-lived ammoniated electrons from γ, 25:57477
- POTASSIUM ANTIMONATES
  - radiation effects on, ESR spectra of radicals from γ, 25:57445
- POTASSIUM BROMIDES
  - analysis for iodine as iodide, potentiometric, 25:57314
  - radiolysis of frozen aqueous solutions of, ESR study of hydrogen atoms and hydroxyl radicals from, 25:57467
  - KBr--$MgBr_2$, spectra at 400°C, Raman, 25:58387(R) (ANL-7823)
- POTASSIUM CHLORIDES
  - analysis for iodine as iodide, potentiometric, 25:57314
  - nitrogen dioxide impurity EPR spectrum in x-irradiated, hindered rotation from, 25:59199 (NYO-2150-74)
  - radiolysis of frozen aqueous solutions of, ESR study of hydrogen atoms and hydroxyl radicals from, 25:57467
  - KCl--LiCl, plutonium oxidation in molten, chronopotentiometric study of, 25:57420
  - KCl--$PbCl_2$, spectra at 400°C, Raman, 25:58387(R) (ANL-7823)
  - KCl--$PbCl_2$, spectra at 590°C, Raman, 25:58387(R) (ANL-7823)
  - KCl--RbCl, radiation effects on electric conductivity of crystals of, effects of divalent cation impurities on 1.2-MeV-electron, 25:59172
- POTASSIUM CHLORORHENATES
  - radiation effects on crystals of, thermal annealing of recoil rhenium atoms from proton, 25:57497
- POTASSIUM CHROMATES
  - complexes with oxalates, radiation effects on, reactions of recoil chromium-51 from, 25:57490
- POTASSIUM FLUORIDES
  - radiolysis of frozen aqueous solutions of, ESR study of hydrogen atoms and hydroxyl radicals from, 25:57467
- POTASSIUM IODATES
  - analysis for iodine as iodide, potentiometric, 25:57314
- POTASSIUM IODIDES
  - radiolysis of frozen aqueous solutions of, ESR study of hydrogen atoms and hydroxyl radicals from, 25:57467
  - KI--MgI_2, spectra at 400°C, Raman, 25:58387(R) (ANL-7823)
  - KI--NaF, effects on direct spectrographic determination of trace amounts of metals in tungsten trioxide, 25:57335
- POTASSIUM IONS
  - electron reactions with, model potentials for, 25:58772
- POTASSIUM ISOTOPES K-40
  - content of foods in Kiev region of Soviet Union, 25:57987
- POTASSIUM ISOTOPES K-43
  - evaluation for scintigraphy of myocardium in dogs, 25:58041 (UCLA-12-837)
- POTASSIUM PEROXYDISULFATES
  - reactions with hexavalent neptunium, kinetics of, 25:57412
- POTASSIUM THORIUM FLUORIDES
  - crystal structure, 25:57298 (ORNL-4676, pp 73-138)
- POWDERS
  - density of flowing, in reservoir, radiometric gage for measuring, 25:57872(P)
  - sintering mechanisms of, effects of particle density distribution and characteristics on, 25:58389(R) (SRO-552-8)
- POWER CYCLES
  - operating characteristics of Brayton, for gas cooled power reactors with closed cycle gas turbines and secondary air cooling system, 25:60140
- POWER PLANTS
  - design of MHD, using liquid metal emulsion with gas turbines associated with high-temperature gas reactor, 25:58841
- PRAIRIE ISLAND POWER REACTOR, UNIT 1
  - construction of, request for not suspending permit for, 25:59963 (DOCKET-50282-41)
- PRAIRIE ISLAND POWER REACTOR, UNIT 2
  - construction of, request for not suspending permit for, 25:59963 (DOCKET-50282-41)
- PRASEODYMIUM
  - abundance on surfaces of peculiar A stars, (E/T), 25:58462
  - complexes with DPTA, spectrophotometric studies on,

  25:57549
- complexes with HEDTA, dissociation constants for, 25:57537
- determination in cobalt alloys, spectrographic, 25:57313
- oxidation potential for trivalent--tetravalent, 25:57437
- separation from aqueous solutions by solvent extraction using DTPA, studies for, 25:57549
- separation from fission products by electromigration following complexing with nitrilotriacetic acid, 25:57558
- solubility in chromium at 1000 to 1800°C, metallographic, microhardness, and x-ray diffraction measurements on, 25:58237

PRASEODYMIUM IONS
- energy level calculations for Pr III and Pr IV, using Hartree--Fock method, 25:58709
- energy level configuration interactions in Pr IV, $4f^2$, (T), 25:58798

PRASEODYMIUM ISOTOPES Pr-141
- neutron total cross section at 1 to 18 MeV, (E), 25:59811

PRASEODYMIUM ISOTOPES Pr-144
- energy-level transitions in, K conversion coefficient for, (E), 25:59790

PRASEODYMIUM OXIDES
- diffusion of oxygen in polycrystalline Pr_7O_{12}, (E/T), 25:58372

PREAMPLIFIERS
- design and performance of low-noise wide-band current-pulse, for neutron counters, 25:57751
- feedback techniques for, application of pulsed, 25:57812

PRESSURE GAGES
- development of electromagnetic, for flowing liquid metals, 25:57646(P)

PRESSURE VESSELS
- bibliography on prestressed concrete, 25:57609 (AED-C-1-18)
- design characteristics of rock shaft mounted prestressed concrete, for power reactors, 25:60071(P)
- design of reactor prestressed concrete, with uniform distribution of stresses from lid to wall, 25:60069(P)
- design of reactor, with prestressed concrete walls and steel cover, 25:60258(P)
- design of reactor, with thin steel shells surrounded by bolted stacks of metal rings, 25:60070(P)
- fracture characteristics of water cooled reactor, effects of steel thickness on, 25:60075
- prestressing concrete for, steel rope wrapping method for, 25:60063
- properties of steel, for Czechoslovak power reactors, 25:58216 (ZJE-106)
- radiation effects on nil-ductility transition temperature of reactor, surveillance program on neutron, 25:58294 (BAW-10006(Rev.2))
- stress analysis of power reactor, finite element method for, 25:60142
- temperature distribution in prestressed concrete, for heavy water moderated boiling power reactors, 25:60080
- thermal stress limits for prestressed concrete, for heavy water moderated boiling power reactors, 25:60081
- valves for BWR-type power plant, design of safety, 25:57637

PROMETHIUM
- abundance on surfaces of peculiar A stars, (E/T), 25:58462
- oxidation potential for trivalent--tetravalent, 25:57437
- separation from neptunium and plutonium by ion exchange chromatography on zirconium phosphate, 25:57550
- separation from other rare earths by electrophoresis in Complexon III on cellulose or silica gel, 25:57299

PROPANE
- radioinduced solvated electrons in liquid, absorption spectrum and half-life of pulsed electron, 25:57468

PROPANE, 2-METHYL-
- yields from γ radiolysis of gaseous ethylene in presence of 2-methylpropene, 25:57474

PROPELLANTS
- analysis of solid rocket, for potassium and sodium by neutron activation and gamma spectroscopy, 25:57384

PROPENE, 2-METHYL-
- effects on yields from γ radiolysis of gaseous ethylene, 25:57474
- radioinduced polymerization under superdry conditions, γ, 25:57450 (ORO-3667-1)

PROPYLENE OXIDE
- radiolysis of clathrate hydrates of, stability of radicals from γ, 25:57476

PROSPECTING
- instruments for radioactive ore, radiometric, 25:57867
- method for uranium, evaluation of pulsed neutron well logging, 25:57560 (INP-732)

PROTACTINIUM
- electromigration behavior of, in CDTA and EDTA, 25:57520 (JINR-E6-5952)
- oxidation potential for trivalent--tetravalent, 25:57437
- phase formation in, studies of high-temperature fcc, 25:58291
- preparation of thin films of, by electrophoresis and electrospraying, 25:58183 (CONF-711002-, pp 160-5)
- redox potential of, in MSBR fuel solvent salt, 25:57298 (ORNL-4676, pp 73-138)
- separation from MSBR fuel by fluorination and reductive extraction, 25:57522 (ORNL-4676, pp 234-71)
- separation from MSBR fuel by oxide precipitation, 25:57522 (ORNL-4676, pp 234-71)
- separation from oxalic and tartaric acids by solvent extraction using tributylamine, 25:57546

PROTACTINIUM ISOTOPES
- cross section measurements of, nondestructive and destructive methods of analysis used in fabrication of targets for, 25:57345 (CONF-711002-, pp 293-306)

PROTACTINIUM ISOTOPES Pa-230
- beta and electron-capture decay of, electron, gamma, and x-ray spectra from, (E), 25:59800
- beta decay of, branching ratios and log-ft and Q values for, (E), 25:59800
- electron-capture decay of, branching ratios and log-ft and Q values for, (E), 25:59800

PROTACTINIUM ISOTOPES Pa-231
- production by neutron irradiation of thorium-230 and thorium-232 mixtures, 25:57479 (BMBW-FBK-71-6)

PROTACTINIUM ISOTOPES Pa-232
- beta decay of, branching ratios, conversion electron and gamma spectra, and log-ft and Q values for, (E), 25:59798

PROTEINS
- catabolism and transport mechanisms for, 25:60277(R) (NYO-3515-5)
- radiation effects on electrophoretic pattern of human saliva, 25:57945
- radioinduced formation of immunoglobulin-like, in bursectomized chickens, x, 25:57934

PROTON CROSS SECTIONS
- library for, description of LRL evaluated, (E), 25:59783 (UCRL-50400(Vol.4))

PROTON SPECTROMETERS
- amplifier for satellite-borne, design of, 25:57821
- coincidence system for satellite-borne, design of, 25:57821

PROTONS
- abundance in H I regions, (E/T), 25:58630
- channeling in crystals, calculation of electronic and nuclear stopping powers for, 25:59129
- dechanneling in germanium, (E/T), 25:59130
- density in midlatitude ionosphere and magnetosphere associated with magnetic storms, dynamics of thermal, (E), 25:58867
- detection and discrimination of recoil, from alpha particles in nuclear emulsions, processing method for, 25:57731
- dose fields in human hip and neck, comparison of calculated and experimental, 25:58023
- dose to space missions, risk of solar, (E/T), 25:58853 (N-71-27792)
- effects on heating of gases, optical line spectra due to, (T), 25:58629
- effects on metal foils at MeV ranges, design of low-temperature facility for studies of, 25:57620 (RISO-204)
- effects on n- and p-type germanium, annealing and energy level spectrum of defects produced by 600-MeV, 25:59159
- effects on potassium chlororhenate or sodium perrhenate, thermal annealing of recoil rhenium atoms from, 25:57497
- effects on production of krypton fluorides, 25:57455
- effects on swelling of helium-containing Type 316 stainless steel at 500°C, 25:58167(R) (AI-AEC-12987)
- effects on tantalum films at 150 keV and low temperature, 25:59160
- effects on void formation in Type 316 stainless steel, relations with flux and temperature, 25:58166(R) (AI-AEC-12980)
- emission during solar flares, longitude effects on delay of, (E), 25:58612
- form factors from $e^+ + e^- \to p +$ anti p interactions, scaling law for, 25:59361
- intensity in morning sector of auroral zone during slowly varying cosmic-noise absorption, (E), 25:58891
- intensity measurements of 0.25- to 1.65-MeV, in radiation belt, (E), 25:58890
- interactions anti d + p at 13.3 GeV/c, CPT invariance test from ratio of total cross sections of anti p + d interactions at 6.65 GeV/c to total cross sections of, (E), 25:59275
- interactions anti n + p, total cross sections for, (E), 25:59275
- interactions anti p + p → 2 anti p + 2p at 7 GeV/c, upper limit for cross sections for, (E), 25:59267
- interactions anti p + p → $2\pi^+ + 2\pi^-$ at 2.5 GeV/c, production of rho, f, and S*(1070) in, (E), 25:59271
- interactions anti p + p → 4π, isobaric five-point amplitude for, 25:59470
- interactions anti p + p → anti n + n at 232 MeV in bubble chamber, cross sections and angular distributions for, (E), 25:59266 (SJC-P-71-1)
- interactions anti p + p → anti p + p + $\pi^+ + \pi^-$ at 7 GeV/c, production of $\Delta^{--}(1236)$, $\Delta^{++}(1236)$, $N\pi\pi(1460)$, and $N\pi\pi(1712)$, and rho(765) in, (E), 25:59267
- interactions anti p + p → anti p + p at 232 MeV in bubble chamber, cross sections and angular distributions for, (E), 25:59266 (SJC-P-71-1)
- interactions anti p + p → $K^+(\pi^+) + K^-(\pi^-)$ at 7 GeV/c,

upper limits for cross sections for, (E), 25:59267
interactions anti $p + p$ at 2.5 GeV/c, cross sections for final states and resonance production in, (E), 25:59272
interactions anti $p + p$ at 6.65 GeV/c, total cross sections for, (E), 25:59275
interactions $d + p \to (np) + p$ at 2 to 160 MeV, three-body separable potential for, 25:59510
interactions $d + p \to (pp) + n$ at 2 to 160 MeV, three-body separable potential for, 25:59510
interactions $d + p \to p + d$ at 2 to 160 MeV, three-body separable potential for, 25:59510
interactions $e + p \to e + \pi^0 + p$, differential cross sections for, (E), 25:59353
interactions $e + p \to e + \pi^0 + p$, test of dip mechanisms in hadron interactions using, (T), 25:59346
interactions $e + p$ up to 18 GeV at 18 to 34°, form factors, scaling, and cross sections for inelastic, (E), 25:59242
interactions $e + p$, asymptotic scaling of structure functions for, 25:59342
interactions $e + p$, field theory for Compton scattering amplitude and duality in deep inelastic current, (T), 25:59363
interactions $e + p$, hadron electrodynamics in resonance model for, 25:59386
interactions $e + p$, radiative corrections to inelastic, 25:59366
interactions $e + p$, two-photon generation mechanism for angular distributions and production cross sections for π^0 production in, (T), 25:59370
interactions $e + p$, vector dominance model for inelastic, 25:59365
interactions $e + p$, wee parton model for single-particle production, 25:59387
interactions $\gamma + p \to \text{eta} + p$ below 1 GeV/c, $S_{11}(1530)$ production in, (T), 25:59514
interactions $\gamma + p \to \gamma + p$ in deep inelastic $e + p$ current interactions, field theory for amplitudes of Compton, (T), 25:59363
interactions $\gamma + p \to \gamma + p$, quark model extension for total and differential cross sections for, (T), 25:59378
interactions $\gamma + p \to \pi^0 + p$ at 4 GeV, cross sections relative to $\gamma + n \to \pi^0 + n$ interactions, (E), 25:59243
interactions $\gamma + p \to \pi^+ + n$, pseudomodel predictions for differential cross sections for polarized, 25:59362
interactions $\gamma + p$ at high energies, Regge pole model for total cross sections of Compton, 25:59340
interactions $K_2^0 + p \to K_1^0 + p$ at 3 and 6 GeV/c, empirical analysis of differences and sums of angular distributions for, (T), 25:59477
interactions $K_2^0 + p \to K_1^0 + p$ at high energies, asymptotical properties of amplitude of, (T), 25:59494
interactions $K^- + p \to \text{anti } K^0 + n$ at 800 to 1200 MeV/c, partial-wave analysis of, (E/T), 25:59293
interactions $K^- + p \to \text{anti } K^0 + n$, test of semi-local duality in backward, (E), 25:59482
interactions $K^+ + p \to \text{anti } \Lambda + p + p$ at 8.25 GeV/c, Veneziano model for, (E/T), 25:59295
interactions $K^+ + p \to \text{anti } \Sigma^0 + p + p$ at 8.25 GeV/c, cross sections for, (E), 25:59295
interactions $K^- + p \to K + \Xi$ at 2 to 5 GeV/c, Regge cut model for near-forward differential cross sections for, 25:59483
interactions $K^+ + p \to K^0 + \pi^0 + \Delta^{++}$ at 2.5 to 5.0 GeV, rotation of symmetry axis in $K + \pi$ interactions from, 25:59502
interactions $K^- + p \to K^- + p$ at 800 to 1200 MeV/c, partial-wave analysis of, (E/T), 25:59293
interactions $K^+ + p \to K^+ + \pi^0 + p$, dual + Pomeron analysis of, 25:59490
interactions $K^- + p \to K^- + \pi^0 + p$, dual + Pomeron analysis of, 25:59490
interactions $K^+ + p \to K^+ + \pi^- + \Delta^{++}$ at 2.5 to 5.0 GeV, rotation of symmetry axis in $K + \pi$ interactions from, 25:59502
interactions $K^- + p \to K^+ + \Xi^-$ at high energies, two-Reggeon cuts and exotic exchange in, (T), 25:59618
interactions $K^- + p \to K^-(\text{anti } K^0) + p(n)$ near 1.670 GeV in hydrogen bubble chamber, differential cross sections for, (E), 25:59281
interactions $K^- + p \to \Lambda(\Sigma^0) + \pi^+ + \pi^-$ at 3.9 to 5.0 GeV/c in hydrogen bubble chamber, Σ^{**} production in, (E), 25:59284
interactions $K^- + p \to p + \pi^- + \text{anti } K^0$ at 3.9 to 5.0 GeV/c in hydrogen bubble chamber, Σ^{**} production in, (E), 25:59284
interactions $K^- + p \to p + \pi^- + \text{anti } K^0$ at 4.6 and 5.0 GeV/c in hydrogen bubble chamber, quasi-two-body cross sections for, (E), 25:59284
interactions $K^- + p \to \pi^- + \pi^+ + \Lambda$, Veneziano five-point function model for, 25:59488
interactions $K^- + p \to \pi^+ + \Sigma^-$ at 2 to 16 GeV/c, Regge cut model for near-forward differential cross sections for, 25:59483
interactions $K^- + p$ at 4.6 and 5.0 GeV/c in hydrogen bubble chamber, quasi-two-body cross sections for production of two charged particles and $\Lambda(\Sigma^0)$ in, (E), 25:59284
interactions $K^+ + p$ at 5 GeV/c, cross sections and angular correlations for six- and seven-body states in, (E), 25:59299
interactions $K^+ + p$ at 8.25 GeV/c, cross sections for Y^* and N^* production in, (E), 25:59295
interactions $K^+ + p$ below 600 MeV/c, s- and p-wave scattering lengths for, (T), 25:59489
interactions $K^+ + p$, empirical analysis of differences and sums of angular distributions for, (T), 25:59477
interactions $K^- + p$, empirical analysis of differences and sums of angular distributions for, (T), 25:59477
interactions $\Lambda + p$, cross sections for elastic, (T), 25:59525
interactions $n + p \to d + 2\gamma$ at 0.025 eV, cross sections and photon angular and spectral distributions for, (T), 25:59527
interactions $n + p \to d + \gamma$, relation of effective Lagrangian for nonleptonic weak interactions with Lagrangian for, (T), 25:59418
interactions $n + p \to \pi^0 + d$ from threshold to 720 MeV, test of isospin invariance in, (E/T), 25:59268
interactions $n + p$ at low energies, scattering amplitudes for, (E), 25:59696
interactions $p + d \to p + d$ at 70 GeV, emulsion study of differential cross sections and slope parameters for, (E), 25:59273
interactions $p + d$ at 12.8 GeV/c, Glauber multiple scattering model for elastic, (E/T), 25:59269
interactions $p + p \to 2p + m\pi^+ + m\pi^-$ at high energies, charge-conservation model for, (T), 25:59512
interactions $p + p \to p + \text{anything}$ at 20 to 1500 GeV, diffraction-model analysis of, (T), 25:59511
interactions $p + p \to p + p + \gamma$ at 99 MeV, elastic pp phase shifts from, (E/T), 25:59520
interactions $p + p \to p + p$ at 50 GeV, emulsion study of differential cross sections and slope parameters for, (E), 25:59273
interactions $p + p \to p + p$, spin extension of Chou--Yang model for differential cross sections of, (T), 25:59513
interactions $p + p \to \pi + \text{anything}$ at 12.4 to 1500 GeV, diffraction-model calculations of meson (π) multiplicities and spectra in, (T), 25:59511
interactions $p + p \to \pi^+ + d$ at 425 MeV, polarization and differential cross section for, (E), 25:59270
interactions $p + p \to X + \text{anything}$ at high energies, scaling law in dual-resonance model for deep inelastic, (T), 25:59428
interactions $p + p$ at 14.25 to 70 GeV/c, phenomenological study of inclusive single-particle spectra of π^-, π^+, K^-, K^+, anti p, and p in triple Regge limit for, (T), 25:59505 (JINR-E2-6031)
interactions $p + p$ at 1500 GeV in CERN ISR, angular distribution of secondary particles from production in, 25:59277
interactions $p + p$ at high energies, charge-conservation model for multiple hadron production in, (T), 25:59512
interactions $p + p$ at high energies, experimental test of Pomeranchuk theorem in, 25:59424
interactions $p + p$, effect of charge asymmetry on scattering length for, (T), 25:59701
interactions $p + p$, two-photon generation mechanism for angular distributions and production cross sections for π^0 production in, (T), 25:59370
interactions $\pi + p$ at high energies, experimental test of Pomeranchuk theorem in, 25:59424
interactions $\pi^+ + p \to 2\pi^+ + \pi^- + p$ at 5 GeV/c, analysis of angular distributions in A_1 and A_2 regions in, (T), 25:59475
interactions $\pi^- + p \to A_2^- + p$ at 3.9 and 16 GeV/c in bubble chamber, A_2^- production mechanism in, (E), 25:59279
interactions $\pi^+ + p \to \Delta^{++} + \text{eta}^0$ at 5 GeV/c, cross sections and spin-density matrix elements for, 25:59297
interactions $\pi^+ + p \to \Delta^{++} + \pi^0$ at 5 GeV/c, cross sections and spin-density matrix elements for, 25:59297
interactions $\pi^+ + p \to \Delta^{++} + \pi^+ + \pi^-$ at 8 GeV/c, S-wave resonance effects in $\pi + \pi$ interactions from, (E/T), 25:59296
interactions $\pi^- + p \to \text{eta} + n$ at 1.6 and 2.3 GeV/c, angular distribution predictions for, (T), 25:59477
interactions $\pi^- + p \to \text{eta} + n$, complex A_2 Regge trajectory for analyzing, (T), 25:59479
interactions $\pi^- + p \to K^0 + \text{anti } K^0 + n$ at 12 GeV/c, generalized Veneziano model for, (T), 25:59492
interactions $\pi^- + p \to K^+ + K^- + n$ at 11.04 GeV/c, mass and width of phi from optical spark chamber study of, (E), 25:59301
interactions $\pi^- + p \to K^+ + \Sigma^-$ at 2 to 16 GeV/c, Regge cut model for near-forward differential cross sections for, 25:59483
interactions $\pi^- + p \to \Lambda^0 + K^0$, $\Lambda^0 \to p + \pi^-$ at 1.07 GeV/c, Λ^0 magnetic moment from, (E), 25:59294
interactions $\pi^- + p \to n + \pi^+ + \pi^-$ at 7 GeV/c, production of $g^0(1670)$ in, (E), 25:59288
interactions $\pi^- + p \to n + X^0$, $X^0 \to \gamma + \gamma$ at 1.6 GeV/c, (E), 25:59290
interactions $\pi^- + p \to p + MM^-$ at 3.25 GeV/c with high momentum transfer, differential cross sections for rho-production in, (E), 25:59312
interactions $\pi^- + p \to p + \pi^+ + \pi^- + \pi^- + \pi^0$ at 13 and 20 GeV/c, multi-Regge model for, (E/T), 25:59300

XUM

interactions $\pi^+ + p \to p + \pi^+$ at 5 GeV/c, cross sections and spin-density matrix elements for, (E), 25:59297
interactions $\pi^+ + p \to p + rho^+$ at 5 GeV/c, cross sections and spin-density matrix elements for, (E), 25:59297
interactions $\pi^- + p \to \pi^0 + n$ at 2 to 5 GeV/c, partial wave amplitudes for, (E/T), 25:59304
interactions $\pi^- + p \to \pi^0 + n$ at 3.67 and 4.83 GeV/c, Regge trajectory and isospin invariance in, (E), 25:59289
interactions $\pi^+ + p \to \pi^- +$ anything at 18.5 GeV/c in bubble chamber, cross sections for, (E), 25:59319
interactions $\pi^- + p \to \pi^- +$ anything at 8 to 24.8 GeV/c in bubble chamber, cross sections for, (E), 25:59319
interactions $\pi^+ + p \to \pi^+ + p + \omega$ at 3.7 GeV/c, charge asymmetry on $\omega \to \pi^+ + \pi^- + \pi^0$ Dalitz plot from, (E), 25:59308
interactions $\pi^- + p \to \pi^- + p$ at 3.0 to 5.0 GeV/c and 55 to 130°, scintillation counter and spark chamber study of angular distributions for, (E), 25:59285
interactions $\pi^+ + p \to \pi^+ + p$ at 3.0 to 5.0 GeV/c and 55 to 130°, scintillation counter and spark chamber study of angular distributions for, (E), 25:59285
interactions $\pi^- + p \to \pi^- + p$, spin amplitudes for, (T), 25:59471 (CEA-N-1456)
interactions $\pi^- + p \to \pi^+ + \pi^- + n$, S-wave $\pi\pi$ phase shift from, (E), 25:59306
interactions $\pi^- + p \to \pi^- + \pi^- + \pi^+ + p$ at 7 and 25 GeV/c, production and decay of $N^*(1500)$ and $N^*(1700)$ in, 25:59307
interactions $\pi^+ + p \to rho^0 + \Delta^{++}$ at 11.7 GeV/c, Regge-pole analysis of, (E/T), 25:59499
interactions $\pi^+ + p \to rho^0 + \Delta^{++}$ at 11.7 GeV/c, total and differential cross sections for, (E/T), 25:59315
interactions $\pi^- + p \to rho^0 + n$ at 11 GeV/c, Regge-pole analysis of, (E/T), 25:59499
interactions $\pi^- + p \to rho^0 + n$ at 7 GeV/c in bubble chamber, angular distributions from, (E), 25:59286
interactions $\pi^+ + p \to \Sigma^+ + K^+$ at 1.28 and 1.41 GeV/c, test of charge independence in, (E/T), 25:59311
interactions $\pi^+ + p$ at 1.28 to 1.84 GeV/c, total and differential cross sections for elastic, (E), 25:59309
interactions $\pi^- + p$ at 2 to 5 GeV/c, partial wave amplitudes for elastic, (E/T), 25:59304
interactions $\pi^- + p$ at 3.25 GeV/c in hydrogen bubble chamber, rho⁻ and rho⁰ peripheral production cross sections and cross sections for two-prong, (E), 25:59314
interactions $\pi^+ + p$ at 3.6 GeV/c in hydrogen bubble chamber, differential cross sections for elastic, (E), 25:59292
interactions $\pi^+ + p$ at 8 GeV/c, spin analysis of g-meson from, 25:59298
interactions $\pi^+ + p$ at 8.5 GeV/c, particle momentum distributions for two-, four-, six-, and eight-prong, (E), 25:59317
interactions with electrons, bremsstrahlung from, (T), 25:58837
production in p + p interactions at 14.25 to 70 GeV/c, phenomenological study of inclusive single-particle spectra in triple Regge limit for, (T), 25:59505 (JINR-E2-6031)
ratio to pions at altitudes of 800 gm/cm^2, non EAS-associated, (E), 25:58834
reactions (p,3n) with germanium-70 at 30 to 55 MeV, cross sections for, (E), 25:59747
reactions (p,γ) with aluminum-27 near 1 MeV, precise γ-ray energies and Q-value for, (E), 25:59762
reactions (p,γ) with calcium-48 at 4 to 18 MeV, excitation function and gamma spectrum from, (E), 25:59742
reactions (p,γ) with copper-63 at 2 to 18 MeV, gamma spectra from, (E), 25:59742
reactions (p,γ) with gold-197, indium-115, silver, and tantalum-181 at 4 MeV, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801
reactions (p,γ) with nickel-60 near 1.6 MeV, γ spectra and angular distributions for, (E), 25:59764
reactions (p,γ) with silicon-29 at 900 to 2120 keV, γ spectra from, (E), 25:59760
reactions (p,γ) with titanium-46 at 1350 to 2280 keV, excitation function for, (E), 25:59752
reactions (p,He-4) with beryllium-9 and boron-11, mechanisms for differential cross sections and angular distributions for, (E), 25:59711 (UCLA-10-P-18-32)
reactions (p,n) with A = 26 to 165 nuclei at 23 MeV, spectra and DWBA analysis of angular distributions from, (E), 25:59789
reactions (p,n) with tritium at 3 to 16 MeV, polarization transfer at 0° in, (E), 25:59695
reactions $(p,n\gamma)$ with calcium-48 near 2 MeV, γ and conversion electron spectra from, (E), 25:59756
reactions (p,pd) with helium-3 at 35 MeV, effect of neutron pickup on quasi-free scattering, (E), 25:59702
reactions in lead at 0.85 to 1.7 GeV/c, neutron yield from, (E), 25:59820
reactions with ammonium rhenate and osmium targets, production of radioactive rhenium isotopes by, 25:57480 (JINR-P6-5955)
reactions with atoms, approximate analytical expressions and scaling relations for excitation and ionization cross sections for, 25:58740
reactions with atoms, effects of orbital momentum on formation of highly excited hydrogen atoms in, (T), 25:58734
reactions with carbon-12 at 0.1 to 660 MeV, intranuclear cascade model for, (T), 25:59265 (JINR-P2-5991)
reactions with carbon-12 to 1 TeV, effect of intermediate resonance production on cross sections for elastic and inelastic, 25:59519
reactions with gases, summary of experimental data on electron capture and loss in, 25:58742
reactions with helium at 10 to 130 keV, excitation of autoionizing levels in, (E), 25:58779
reactions with hydrogen 2s atoms, transition to ground state in, (T), 25:58746
reactions with hydrogen atoms at high energies, total inelastic and charge-exchange cross sections for, (T), 25:58775
reactions with hydrogen atoms at low energies, formal theory of, 25:58771
reactions with hydrogen atoms, Glauber amplitudes for excitation of ns and np levels in, (T), 25:58766
reactions with hydrogen molecules and rare gas atoms, review of charge exchange in, (E), 25:58743
reactions with iron at 400 GeV, Monte Carlo calculations of nucleon- and meson (π)-induced star and flux distributions from, (T), 25:59507 (ORNL-4673)
reactions with iron-56 to 1 TeV, effect of intermediate resonance production on cross sections for elastic and inelastic, 25:59519
reactions with natural aluminum, magnesium, and silicon at 6 to 52 MeV, cross sections for aluminum-26 and sodium-22 formation in, (E), 25:59753
reactions with nuclear emulsions at 28 GeV, energy spectra of lithium-8 fragments from, (E), 25:59278
reactions with nuclei, isobaric-spin conservation for proton emission probability in compound-nucleus, (T), 25:59830 (CU-1019-82)
reactions with oxygen molecules at 100 eV to 4 keV, energy losses and energy-level transitions in, (E), 25:58753
scattering by aligned holmium-165 at 5 to 10 MeV, deformation parameter and spectra from elastic, (E), 25:59788
scattering by beryllium-9 with subsequent breakup, analysis of $n-{}^{8}Be$ final-state interaction using effective-range approximation, (T), 25:59735
scattering by carbon-12 at 1 GeV, analysis using Glauber theory and α-particle model, (T), 25:59727
scattering by lithium-6, nitrogen-14, and zirconium-90, approximate G-matrix calculations for inelastic, (T), 25:59858
scattering by oxygen-16, effective cross sections for elastic, (T), 25:59509
scattering by titanium-48, chromium, and zinc-64 at 40 MeV, differential cross sections for, (E), 25:59739 (ORNL-TM-3591)
scattering by tungsten at high energy, analysis for recoil-nucleus effects in, (T), 25:59814
scattering from amorphous tungsten oxide surface at 275 keV, spectra of low-angle, (E/T), 25:58689
stopping in aluminum, gold, lithium, and silver at 20 to 1000 keV, electronic, (T), 25:59124
trapping boundaries for 10- to 100-keV, in ring current, (T), 25:58854
variations in high-latitude trapping boundary of 100- to 200-keV, associated with polar magnetic substorms, (E), 25:58866

PROTONS (anti p)
interactions anti $p + d \to p + \pi^+ + 2\pi^- + \pi^0$ at 5.5 GeV/c in deuterium bubble chamber, cross sections for anti $p + n \to \pi^+ + 2\pi^- + \pi^0$ interactions, rate for single rho production, upper limit for double rho production, cross sections, and angular and momentum distributions in, (E), 25:59276
interactions anti $p + d$ at 6.65 GeV/c, CPT invariance test from ratio of total cross sections of anti $d + p$ interactions at 13.3 GeV/c to total cross sections of, (E), 25:59275
interactions anti $p + n \to 2\pi^- + \pi^+$ at rest, five-point function in dual model for, (T), 25:59465
interactions anti $p + n \to \pi^+ + 2\pi^- + \pi^0$ at 5.5 GeV/c in deuterium bubble chamber, cross sections and rate for single rho production and upper limit for double rho production in, (E), 25:59276
interactions anti $p + p \to 2$ anti $p + 2p$ at 7 GeV/c, upper limit for cross sections for, (E), 25:59267
interactions anti $p + p \to 2\pi^+ + 2\pi^-$ at 2.5 GeV/c, production of rho, f, and $S^*(1070)$ in, (E), 25:59271
interactions anti $p + p \to 4\pi$, isobaric five-point amplitude for, 25:59470
interactions anti $p + p \to$ anti $n + n$ at 232 MeV in bubble chamber, cross sections and angular distributions for, (E), 25:59266 (SJC-P-71-1)
interactions anti $p + p \to$ anti $p + p + \pi^+ + \pi^-$ at 7 GeV/c, production of $\Delta^{--}(1236)$, $\Delta^{++}(1236)$, $N\pi\pi(1460)$, and $N\pi\pi(1712)$, and rho(765) in, (E), 25:59267
interactions anti $p + p \to$ anti $p + p$ at 232 MeV in bubble chamber, cross sections and angular distributions for, (E), 25:59266 (SJC-P-71-1)
interactions anti $p + p \to K^+(\pi^+) + K^-(\pi^-)$ at 7 GeV/c, upper limits for cross sections for, (E), 25:59267

XUM

  interactions anti p + p at 2.5 GeV/c, cross sections for final states and resonance production in, (E), 25:59272
  interactions anti p + p at 6.65 GeV/c, total cross sections for, (E), 25:59275
  production in p + p interactions at 14.25 to 70 GeV/c, phenomenological study of inclusive single-particle spectra in triple Regge limit for, (T), 25:59505 (JINR-E2-6031)
PROTOZOA
  Stylonychia mytilus, radiation effects on appearance of pseudomicronuclei in progeny of, x, 25:58096
  Tetrahymena pyriformis, radiosensitivity of growth and DNA and RNA stability and synthesis in, effects of concentration of dactinomycin on γ, 25:58091
PULSARS
  CP 0950, microsecond intensity variations in radio emissions from, (E), 25:58562
  decay of, in binary systems, (T), 25:58424
  emission mechanism for, (T), 25:58549
  mechanism in supermassive disks undergoing fragmentation, (T), 25:58668
  model for, featuring rapidly rotating supermassive, quasar, (T), 25:58496
  NP 0532, position determination for, (E), 25:58537
  NP 0532, radio pulse arrival times at Arecibo, (E), 25:58559
  NP 0532, search for pulsed gamma emission from, (E), 25:58542
  particle escape into nebula from, gamma-ray production by, (T), 25:58550
  period of, (E), 25:58545
  polarization at 410 and 1665 MHz, linear and circular, (E), 25:58551
  position of, (E), 25:58545
  PSR 0329 + 54, mode changing in pulses from, 25:58569
  PSR 0833-45, interstellar scattering and low-frequency spectrum of, (E), 25:58540
  PSR 1237 + 25, mode changing in pulses from, 25:58569
  pulse characteristics of, (E), 25:58545
  radiation mechanism for, (T), 25:58431
  radio emission from, slow variations of, (T), 25:58522(T) (CSIRO-Trans-10649)
  radio emissions from, effects of dispersion by interstellar medium on, (E), 25:58562
  rotation measures of, (E), 25:58545
  spectra of, effects of induced Compton scattering by thermal electrons on, (T), 25:58527
PULSE CONVERTERS
  design of MOSFET current-to-frequency, for monitoring ion-chamber currents in subpicoampere-to-microampere range, 25:57894
  nomenclature for voltage-comparing analog-to-digital, proposed, 25:57886
PULSE GENERATORS (ELECTRONICS)
  circuits for programmable solid-state, for charge-sensitive amplifiers, 25:57896
PULSE GENERATORS (PNEUMATICS)
  performance in compacting sol-gel uranium dioxide, 25:58364
PULSE SHAPERS
  circuits for fixed-discrimination-level and constant-fraction-of-pulse height, with subnanosecond outputs for nuclear physics, 25:57786
PUMPS
  production of centrifugal, development of Canadian facilities for, 25:57608 (70-CNA-658)
PUMPS (LIQUID METAL)
  design problems with liquid sodium cooled fast reactor primary, 25:60077
PUREX PROCESS
  efficiency for fast breeder fuel element reprocessing, 25:57518(T) (EURFNR-888)
  hydrazoic acid formation and destruction in, 25:57511 (BNWL-B-121)
  nitrous acid elimination from organic stream in, 25:57511 (BNWL-B-121)
  solvent cleanup using macroreticular ion exchange resins in, 25:57509 (ARH-SA-58)
PURINES
  formation in early solar system by catalytic synthesis, (E/T), 25:58575
  formation in early solar system by catalytic synthesis, (E/T), 25:58576
PYRIMIDINES
  formation in early solar system by catalytic synthesis, (E/T), 25:58576
  formation in early solar system by catalytic synthesis, (E/T), 25:58575
PYRITES
  analysis for cobalt by neutron activation and spectrometry, 25:57386
PYROMETERS
  design of thermoelectric, 25:57761(P)
PYROXENES
  analysis for cobalt by neutron activation and spectrometry, 25:57386
PYRROLIDINONE, VINYL-
  reactions with solvated electrons, rate constant of, 25:57475

Q

QUAD CITIES POWER REACTOR, UNIT 1
  testing of, request for authorization for initial, 25:59949 (DOCKET-50254-53)
QUAD CITIES POWER REACTOR, UNIT 2
  loading of, request for authorization for initial, 25:59949 (DOCKET-50254-53)
  testing of, request for authorization for initial, 25:59949 (DOCKET-50254-53)
QUALITY CONTROL
  method for laboratory, computerized, 25:57611 (CTC-51)
  method using gamma radiography, efficiency evaluation of, 25:57696
QUANTUM ELECTRODYNAMICS
  charge-current commutator in, equal-time, 25:59566
  CP violation from, mechanism for, 25:59539
  electron g-factor anomaly from, (E), 25:59560
  interactions in, Lagrangian theory for, 25:59563
  model for number and momentum distributions, total cross sections, and amplitudes for production of electron pairs in e + e interactions in, infinite-momentum, 25:59345
QUANTUM FIELD THEORY
  Bjorken limit in, point-source static model for renormalized field product for, 25:59564
  commutation relations from orthogonal transformations in, inequivalence of representations of, 25:59567
  derivatives of infinite-dimensional free massless fields in, covariant, 25:59582
  eikonal approximation for Feynman diagrams in, 25:59579
  eikonal approximation in neutral scalar, 25:59569
  Feynman diagrams in, regularization of three-vertex, 25:59568
  field algebra, review on, 25:59324
  field operators for hadron interactions, bilocal, 25:59583
  formalism for free fields in, Clifford algebras for, 25:59563
  gauge transformations for electromagnetic interactions in, internal symmetries from, 25:59545
  interactions in, wave mechanical theory for, 25:59563
  Lagrangian in, invariant perturbation theory for nonlinear chiral, 25:59574
  Lagrangian, generalization on basis of function manifold, 25:59559
  Lee model in, properties of, 25:59575
  LSZ formulation for spin-two mesons, 25:59570
  mesons in, gauge-invariant Lagrangian for massive vector, (T), 25:59555
  model for renormalized field product for Bjorken limit and Ward identity in, point-source static, 25:59564
  model of, convergent expansion for resolvent of phi*, 25:59581
  operators in, generalization of Cook formalism for Fock space for two-body interactions from, 25:59580
  parastatistics with variable numbers of particles in, 25:59561
  quantization method for finite and infinite component fields with arbitrary mass spectra, 25:59557
  renormalized field product for Bjorken limit and Ward identity in point-source static model for, 25:59564
  scattering amplitudes in nonlocalizable, bounds on elastic, 25:59565
  strong interactions in, point-source static model for renormalized field product for Bjorken limit and Ward identity for, 25:59564
  theory for Euclidean, analogies between statistical mechanics and, 25:59622
  theory in curved space--time, connection for, 25:59578
  three-body problem in, three-dimensional covariant formulation of, 25:59577
  vacuum degeneration for charged scalar field with self-interaction in case of one spatial degree of freedom, 25:59576
  Ward identities in, anomalies in, 25:59572
  Ward identity in, point-source static model for renormalized field product for, 25:59564
  Yang--Mills field in, massive and massless, 25:59601
  Yang--Mills fields in, renormalization of massless, 25:59571
QUANTUM MECHANICS
  angular momentum reduction in three-body problem, nonexhaustive restatement of, 25:59206 (LYCEN-7118)
  book: Scattering, Reactions, and Disintegrations in Nonrelativistic Mechanics (in Russian), 25:59612
  bound-state equations in, factorization method of solution of, 25:59227
  exclusion principle in, effects on permutation group, (T), 25:59235
  group theory for permutation degeneracy in four electrons in, (T), 25:59235
  Hamiltonian and Lagrangian formalisms in, consistency between, 25:59558
  Hamiltonian in, construction of diagonal sets commuting with, 25:59222
  Hartree--Fock equation in, formulation and solutions of unrestricted, 25:59239
  P representation in, equation of motion for, 25:59208
  parastatistics with variable numbers of particles in, 25:59561

representations in phase space, (T), 25:59234
Schroedinger equation in, approximate methods for solving, 25:59205 (JINR-E2-6043)
Schroedinger equation in, solutions for time-dependent interactions, 25:59207 (NP-19033)
unitary representation up to factor of Galilei group in Hilbert space, continuous irreducible, (T), 25:59217

QUARTZ
radiation effects on frequency vs temperature characteristics of crystals of synthetic, gamma and neutron, 25:57906

QUASARS
distribution of, (E/T), 25:58567
evolution into galactic nuclei, (T), 25:58626
flux density of, fluctuations of, (E), 25:58556
fragmentation in, (T), 25:58668
luminosity functions of, at 400 and 2700 MHz, (E), 25:58644
luminosity of, (T), 25:58659
model for formation from quasags, (T), 25:58523(T) (CSIRO-Trans-10650)
model for, featuring rapidly rotating supermassive stars, (T), 25:58496
occultation of, solar, (E), 25:58662
optical identification for five, (E), 25:58538
optical monitoring of twenty, (E), 25:58568
polarization of 3C 279, evolution at 8 GHz of linear, (E), 25:58556
position of 3C 273B, (E), 25:58566
radio intensity variations of 3C 273, at 2.3 and 8.15 mm, (E), 25:58524
spectra of, effects of induced Compton scattering by thermal electrons on, (T), 25:58527
spectral redshifts of, (T), 25:58666
spectral redshifts of, selection effects in measurement of, (E/T), 25:58567

R

RABBITS
nitrogen content of blood of, following administration of mercuric chloride and uranium, 25:58099
radiation dose to, effectiveness of blood plasma-quenching effect for measuring whole-body γ, 25:58017
radiation effects on iodine-131 clearance rate in skin of, x, 25:58125
radiation effects on survival of, protective effects of tissue preparations against x, 25:58033
radioinduced heterotopic bone formation in lungs of, x, 25:58133

RADIATION
book: Protection of Animals Against Injury by Nuclear Weapons, 25:58026
book: Radiation Effects on Glass and Ceramics, in Russian, 25:59147
book: Radiation Stability of Lacquer Coatings, 25:58420
dose distribution planning for megavolt therapy, methods for, 25:58007
dose to astronauts during duty on space stations, effects of shielding during solar flares on, 25:58025(T) (ORNL-tr-2490)
dose to astronauts of USSR Soyuz-9 space ship, preflight calculations of, 25:58006
dose to human lungs and pulmonary lymph nodes following acute or chronic inhalation of insoluble plutonium-239, method for calculation of, 25:58001 (UCRL-73388)
dose to man during travel on high-altitude supersonic aircraft, 25:58138
dosimetry in human skin, method for measurement of epidermis thickness for use during, 25:58000 (RD/B/R-1934)
dosimetry in human tissues, concepts and units for, 25:58002
dosimetry in supervoltage therapy, 25:58077
effects of self-, in radioactive solids, time dependence of defect accumulation from, (T), 25:59170
effects on blood cell counts in medical personnel in Japan during 1969, survey of, 25:58134
effects on blood, bone marrow, and lungs of mice and rats, similarity between effects of vaccinal disease and, 25:58128
effects on central nervous system of man, mice, and rats, review of research on, 25:58143
effects on chromosomes in bacteria, role of DNA repair in recovery following aberrant, 25:57970
effects on chromosomes in human peripheral lymphocytes, review of aberrant, 25:57963
effects on circulatory system of laboratory animals, pathological, 25:58122
effects on cyclohexane, kinetics of, 25:57473
effects on development of vesicovaginal fistula in man following therapy of gynecologic neoplasms, 25:58135
effects on diamonds, review of defects produced in, 25:59137
effects on electrophoretic pattern of proteins in human saliva, 25:57945
effects on excretion of catecholamines by man, effects of ACTH on, 25:57938
effects on frequency of chromosome X loss in Drosophila, use as dosimeter, 25:57999 (NP-18944)
effects on hematopoiesis in spleen of mice following transplantation of bone marrow, 25:58117
effects on histology and physiology of nervous system, effects of dose on, 25:58143
effects on human blood vessels and heart following therapy for thoracic diseases, 25:58147
effects on III-V semiconductor compounds, 25:59138
effects on mammalian cells, review of relation between recovery and dose rate in, 25:58088
effects on man following therapy for cervical cancer, effects of adrenal cortex exract on, 25:58035
effects on mice following sublethal hemorrhagic shock, lethal whole-body exposure, 25:58109
effects on normal tissues, additive effects of antineoplastic drugs on therapeutic, 25:58077
effects on results of thromboelastographic examinations among uranium mining personnel, chronic, 25:58144
effects on semiconductors, review of theory of defects in, 25:59131
effects on sensitivity of man to pharmaceuticals, 25:58142
effects on silicon, review of defects produced in, 25:59135
effects on survival of ascites tumor cells in mice, sensitizing effects of iodoacetamide on, 25:58034
effects on thermostability of polyethylene, effects of antioxidants and fillers on, 25:57446
effects on void formation in materials, relations with dose and temperature, 25:58312
effects on void formation in materials, theory of, 25:58314
effects on void formation in reactor materials, conference on, 25:58304
hazards to human populations from artificial and natural sources, 25:57994
hazards to man in industry and medicine, review on, 25:58139
scattering of partially coherent, by free electrons, nonlinear, (T), 25:59225
use for therapy of human carcinomas, role of antitumor immune mechanisms of normal tissues in, 25:58072
uses in medicine and technology, criteria for benefits and hazards of, 25:58030

RADIATION DETECTORS
characteristics of, on TD-1, HEOS-B, and COS-B, (E), 25:58829
circuitry for ΔE--E telescopes of, for charged-particle identification, 25:57722 (CEA-R-4183)
conference on, Vienna, Austria, Nov. 23-27, 1970, 25:57726 (STI/PUB-269)
deadtime correction in counting rapidly decaying sources, 25:57732
design of self-powered ytterbium, 25:57755(P)
design of self-powered, for neutron detection, 25:57728(P)
design of self-powered, for neutron dosimetry, 25:57776
development of glass chamber, using liquid--liquid phase separation for detection of charged particle, 25:57727
energy response of beta--gamma survey, tables of, 25:57781
energy response of neutron survey, tables of, 25:57781
materials evaluation for, 25:59147
operation and uses of self-powered, 25:57777
performance of various, for monitoring outside reactor shielding, 25:57779

RADIATION DETECTORS, ACTIVATION
calculations for fast neutron spectra measurements, 25:57775
data unfolding for, computer program for neutron spectra, 25:57725 (KFKI-71-22)
description for thermal neutron detection, 25:57729(P)
design and performance of multiple, for accident dosimetry of neutrons, 25:57857
development for liquid metal cooled fast breeder reactor power and breeding distributions, 25:60050
preparation for in-core neutron flux monitoring, 25:57724 (CONF-711002-, pp 86-90)
preparation of Al_2O_3--CoO and MgO--CoO, for high-temperature neutron flux measurements, 25:57723 (CONF-711002-, pp 82-5)

RADIATION DETECTORS, BUBBLE CHAMBER
optical system for 75-cm hydrogen, 25:57826 (SJC-T-71-3)
particle tracks in, instrument for measurement of ionization of, 25:57825 (RPP/H-81)
particle tracks in, review of systems for automatic, 25:57827

RADIATION DETECTORS, DIELECTRIC TRACK
development of fission foil--dielectric track detector for neutron dosimetry, 25:57856
development of uranium foil--dielectric track detector for personnel neutron dosimetry, 25:57854
particle tracks in, spark counter readout system for, 25:57855
performance for personnel neutron dosimetry, 25:57855

RADIATION DETECTORS, FISSION CHAMBER
design for neutron flux measurement in water cooled reactors, 25:60046
preamplifiers for, design and performance of low-noise wide-band current-pulse, 25:57751

RADIATION DETECTORS, FISSION FOIL
effectiveness for measuring neutron dose to man in accidental exposure, 25:58019

RADIATION DETECTORS, GEIGER-MUELLER
- characteristics of beta--gamma survey, 25:57782
- design for monitoring environmental gamma doses and dose rates, 25:57721 (AECL-3989)

RADIATION DETECTORS, IONIZATION CHAMBER
- amplifier for segmented, 25:57757(P)
- characteristics of cutie pie, for beta--gamma dosimetry, 25:57782
- current output of, design of MOSFET current-to-frequency converter for measurement of, 25:57894
- design and performance of extrapolation, for measurement of dose distributions at bone--tissue interfaces, 25:57851
- design of cavity-type, air-equivalent properties of Teflon--carbon mixture for, 25:57861
- design of flowthrough, with screen window, 25:57756(P)
- design of quartz-fiber personnel, standard for, 25:57830
- efficiency and response of large-area, for whole-body counting, 25:57772
- operation and uses of liquid, 25:57778

RADIATION DETECTORS, PROPORTIONAL
- characteristics of polyethylene-moderated boron trifluoride, for neutron dosimetry, 25:57782
- data acquisition and electronics system for multiwire hodoscope, design of CAMAC, 25:59656
- design of multiwire, for measuring plutonium content of human lungs, 25:57773
- development for radioisotope imaging in vivo, 25:57774
- development for readout of optically or thermally stimulated exoelectron emission dosimeters, 25:57834
- development of large-area, for measurement of plutonium-239 lung burden in man, 25:57998 (NIRS-Pu-8)
- electrodes for design of foil-supported, 25:57750
- performance of proton recoil, for time-of-flight neutron spectra measurements, (E), 25:60156(R) (GULF-RT-A-10800)
- properties of Rossi tissue-equivalent spherical, for dosimetry, 25:57853

RADIATION DETECTORS, SCINTILLATION
- design for photon counting, 25:57759(P)
- design of collimated, for measurement of alpha activity from plutonium-239 in puncture wounds, 25:57998 (NIRS-Pu-8)
- development of barium fluoride, for charged-particle and gamma-ray detection, 25:57817
- development of large-area, for measurement of plutonium-239 content of human lungs, 25:57998 (NIRS-Pu-8)
- efficiency and response of cylindrical, for whole-body counting, 25:57772
- efficiency of organic, calculation of luminescence, 25:57753
- geometric factors for thallium-activated sodium iodide, for gamma angular correlation measurements, 25:57733
- light output from very thin Pilot B, effects of wave-shifter concentration on, 25:57819
- performance of flat large-area, for high-energy interactions of cosmic rays, 25:57828
- performance of liquid, for detection of carbon-14-labeled compounds, 25:57752
- response of poly(vinyl toluene), at high radiation doses, 25:57765

RADIATION DETECTORS, SEMICONDUCTOR
- characteristics of multiplying, for gamma detection, 25:57748
- charge-carrier lifetime and mobility in p--i--n, determination using sine-modulated light, 25:57738
- design of cadmium selenide or cadmium sulfide, for neutron fluence measurements based on delayed electric conductivity change, 25:57758(P)
- design of intravenous, for blood flow studies using radioisotopes, 25:57760(P)
- development of avalanche, 25:57747
- developments in, 25:57793
- fabrication and testing of indium antimonide and lead oxide, for nuclear particle spectroscopy, 25:57807
- fabrication and testing of, conference on, 25:57734
- performance of probe type, for measuring beta emission from tracer doses of phosphorus-32, 25:58064
- preamplifiers for, application of pulsed-charge feedback to charge-sensitive, 25:57812
- pulse shapes from, averaging techniques for measurement of bias and radiation effects on current, 25:57737
- rectifying process in metal--semiconductor surface-barrier, review of, 25:57741
- sensitivity for x-ray detection and radiography, 25:57766

RADIATION DETECTORS, SEMICONDUCTOR (GERMANIUM)
- background measurement of lithium-drifted, 25:57803
- capacitance characteristics of lithium-drifted p--i--n, measurement of, 25:57802
- carrier trapping in lithium-drifted, derivation and testing of model for, 25:57815
- characteristics of, calculation of, 25:57762
- data-acquisition system for, design and performance of high-count rate two-parameter, 25:57806
- development of p--i--n, review on, 25:57730
- efficiency and solid-angle corrections for five-sided lithium-drifted, 25:59841(R) (ORO-4119-1)
- efficiency calibration of well-type lithium-drifted, for gamma detection, 25:57740
- fabrication and testing of 60-cm^3 well-type lithium-drifted, for activation analysis, 25:57805
- fabrication and testing of gamma, made from high-purity germanium, 25:57814
- fabrication and testing of high-purity n--i--p, for gamma spectroscopy, 25:57811
- fabrication and testing of high-purity p-type, for gamma spectroscopy, 25:57820
- fabrication and testing of high-purity, for gamma and x radiation, 25:57762
- fabrication and testing of well-type lithium-drifted, with <5μ dead layer, 25:57799
- fabrication of lithium-drifted, effects of lithium precipitation in, 25:57735
- pair formation in lithium-drifted, temperature dependence of average energy for electron--hole, 25:57739
- performance for gamma spectroscopy, 25:57822
- performance of large satellite-borne lithium-drifted, for cosmic-ray detection, 25:57791
- performance of lithium-drifted, effects of trapping on, 25:57798
- performance of p--i--n, for measurement of fluence and flux density of low-energy gamma and x radiation, 25:57768
- pulses from gamma irradiation of coaxial and planar lithium-drifted, pulse height, risetime, and spatial distributions of slow, 25:57818
- surface channels on lithium-drifted, effects on electron and x-ray spectra of, 25:57797
- testing of encapsulated lithium-drifted, in liquid nitrogen, assembly for, 25:57800

RADIATION DETECTORS, SEMICONDUCTOR (SILICON)
- amplifers for satellite-borne, circuits for low-power charge-sensitive FET, 25:57821
- amplifiers for space applications of, design and performance of charge-sensitive, 25:57792
- calibration of Maxon--Rae, for neutron-capture cross-section measurements, 25:57789
- capacitance characteristics of lithium-drifted p--i--n, measurement of, 25:57802
- characteristics for use in clinical environments for dosimetry, 25:57743
- characteristics of avalanche, for low-energy x-ray spectroscopy, 25:57771
- characteristics of, calculation of, 25:57762
- coincidence circuits for satellite-borne, 25:57821
- design and characteristics of miniature needle-type lithium-drifted, for measurements of trace activity in vivo, 25:57744
- design and performance of surface-barrier, for planar distribution measurements of low-energy beta sources, 25:57769
- design criteria for radiation-resistant, for neutron detection, 25:57746
- design of avalanche, for in vivo detection of low energy radioisotopes, 25:57770
- development and performance of lithium-drifted, for low-energy x-ray spectrometry, 25:57816
- development of miniaturized, for measurements in vivo, 25:57745
- electron-hole pair formation by alpha particles in lithium-drifted, energy-gap and temperature dependence of average, 25:57788
- fabrication and testing of boron-implanted, for nuclear spectroscopy, 25:57809
- fabrication and testing of small rod-shaped, for medical applications, 25:57808
- fabrication and tests of ion-implanted, for charged-particle detection, 25:57749
- performance for gamma dosimetry, 25:57850
- performance of surface-barrier, for alpha spectroscopy, 25:57794 (INS-TCH-5)
- radiation effects on surface-barrier, 200-keV to 1-MeV electron, 25:57907
- resolution of 5000-μ lithium-drifted, measurement of, 25:57801
- spectral noise intensity of, measurement of, 25:57742

RADIATION DETECTORS, SPARK CHAMBER
- development of self-triggered wire, for clinical gamma-ray scanners, 25:57784

RADIATION DOSE
- control methods for reactor maintenance personnel, 25:59926
- determination of absorbed, in reactor core materials, 25:60160 (STI/DOC-10/127)
- standards for man, use of data on radioisotope uptake and retention in tissues for development of internal, 25:58024 (CONF-711104-1)

RADIATION DOSIMETERS
- calibration for gamma dosimetry, maintenance of electron equilibrium in, 25:57860
- calibration of, 1970 IAEA international glass dosimetry intercomparison for, 25:57838
- development for personnel monitoring, review on, 25:57767
- developments in, review on, 25:57846
- energy calibration for gamma and x rays, 25:57859
- glasses for, properties of, 25:58421
- materials evaluation for, 25:59147
- response of various, for neutron dosimetry behind shielding, 25:57858

RADIATION DOSIMETERS, BIOLOGICAL
- effectiveness for measuring neutron dose to man in

  accidental exposure, 25:58019
  effectiveness of blood plasma-quenching effect as whole-body, 25:58017
  effectiveness of chromosome aberration frequency in human peripheral lymphocytes as, 25:58013
  effectiveness of chromosome aberration frequency in peripheral human lymphocytes as, factors affecting, 25:58014
  effectiveness of chromosome aberration frequency in human peripheral lymphocytes as, for low-dose occupational exposures, 25:58015
  effectiveness of chromosome aberration frequency in human peripheral lymphocytes as, 25:58016
  radioinduced loss of Drosophila chromosome X, 25:57999 (NP-18944)
RADIATION DOSIMETERS, CHEMICAL
  characteristics of tissue-equivalent alanine, using EPR readout, 25:57852
  performance of Fricke, for gamma rays, neutrons, and x rays, 25:57862
  performance of Fricke, for measuring absorbed x-ray dose to brain during therapy of tinea capitis in children, 25:58012
RADIATION DOSIMETERS, EXOELECTRON
  characteristics for gamma dosimetry, 25:57836
  development for personnel neutron dosimetry, 25:57833
  preparation and properties of beryllium oxide, 25:57835
  readout detector for, proportional, 25:57834
RADIATION DOSIMETERS, THERMOLUMINESCENT
  characteristics of lithium borate, with rf heating for readout, 25:57839
  design and performance of dyprosium-activated calcium sulfate, for short-term personnel dosimetry, 25:57847
  design of lithium hydride-doped lithium fluoride, for fast neutrons, 25:57831(P)
  development for personnel dosimetry, 25:57840
  development for personnel neutron dosimetry, 25:57833
  development of high-sensitivity tissue-equivalent manganese silicate, 25:57841
  fabrication of sintered lithium fluoride, which can be reused without regeneration, 25:57848
  performance of calcium sulfide, for mixed gamma and neutron dosimetry, 25:57849
  performance of lithium fluoride--Teflon, for surface dosimetry of beta and gamma radiation, 25:57837
  preparation and properties of combination lithium borate and lithium fluoride, for personnel monitoring, 25:57842
  readout method for, 25:57832(P)
  readout systems for, using hot nitrogen gas for heating, 25:57843
  research at Phillipine AEC, 25:57845
  sensitivity and linearity of calcium fluoride and lithium fluoride, effects of residual thermoluminescence on, 25:57844
RADIATION DOSIMETRY
  methods for personnel at Boris Kidric Institute, 25:58018
RADIATION MONITORING
  developments in, review on, 25:57767
  equipment and method for in-situ seabed, development of gamma, 25:57586
  equipment for automatic surveillance of nuclear power plants, 25:60120
  standard guide for administrative practices in, USA, 25:57714
RADIATION PROTECTION
  standards for, review of development of ICRP, 25:58024 (CONF-711104-1)
RADIATION RATE METERS
  performance for measurement of dose from cobalt-60 applicators during therapy of gynecological neoplasms, 25:58010
RADIATION-SCATTERING ANALYSIS
  method of alpha-particle, for determination of traces of heavy elements in bulk light material, 25:57360
RADIATION SOURCES
  calibration of, gravimetric and volumetric methods for minimizing dilution and sampling errors in, 25:57498 (CONF-711002-, pp 283-92)
  effectiveness of small, for therapy of tumor remnants in human cervix following external γ or x radiotherapy, 25:58074
  lifetime of radioisotope, for gamma radiography, method for determining optimum, 25:57697
RADIATION STANDARDS AND UNITS
  definitions of quality factor, 25:58005
RADIATION TARGETS
  assay of, physical methods for, 25:59640 (CONF-711002-, pp 272-82)
  fabrication of accelerator, methods for, 25:59636 (CONF-711002-, pp 101-7)
  fabrication of tritium, for high-yield neutron source, 25:59670 (CONF-711002-, pp 166-80)
  preparation by heavy-ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
  preparation by ion deposition and implantation, 25:57650 (CONF-711002-, pp 10-20)
  preparation of actinide metal, by casting, 25:59634 (CONF-711002-, pp 59-69)
  preparation of alpha-active, by vacuum evaporation, 25:59638 (CONF-711002-, pp 116-21)
  preparation of radioactive and stable, methods for, 25:59635 (CONF-711002-, pp 91-100)
  preparation of self-supporting isotopic chromium, 25:59633 (CONF-711002-, pp 39-46)
  separation of radioisotopes from, chemical and nuclear methods for, 25:57481 (KURRI-TR-76, pp 8-14)
  thickness and uniformity measurements using charged particles, 25:57863 (CONF-711002-, pp 307-20)
RADIO GALAXIES
  brightness distributions for 54, east--west, (E), 25:58645
  emission in spiral, origin of continuum, (E), 25:58646
  flux densities for 54, (E), 25:58645
  luminosity functions of, at 400 and 2700 MHz, (E), 25:58644
  luminosity of, (T), 25:58659
  lunar occultation of, (E), 25:58538
  positions for 54, (E), 25:58645
RADIO WAVES
  absorption in auroral zone of cosmic-noise, time lag of, (E/T), 25:58863
  absorption in ionosphere, phase-integral calculation of reflected, (T), 25:58875
  absorption of cosmic-noise, correlation with auroral pulsations, (E/T), 25:58858
  deflection in solar gravitational field, (E), 25:58662
  noise absorption in morning sector of auroral zone, effect on incoming proton intensity, slowly varying cosmic, (E), 25:58891
  noise bursts at 3 MHz from lightning-flash radiation, pulse characteristics of, (E), 25:58876
  production in neutral electric-field regions within powerful radio sources, (T), 25:58526
  propagation in ionosphere, effect of geomagnetic field on reflection and transmission of, (T), 25:58869
  propagation in ionosphere, magneto-ionic mode coupling of hf, (T), 25:58871
  propagation in ionosphere, magneto-ionic mode coupling of hf, (T), 25:58870
  propagation under daytime ionosphere, geomagnetic-field effect on 1 to 4 kHz elf and vlf, (T), 25:58873
  survey at 1400 MHz, 5C1 sources, (E), 25:58531
RADIOACTIVE CONTAMINATION
  evaluation of environmental, following Schooner Event, 25:57574 (PNE-524)
  monitoring in environs of Aiken, S. C. and Oak Ridge, Tenn. during 1969, 25:57985
  possibility of environmental, by excretions from patients during interstitial iodine-131 therapy, 25:58079
RADIOACTIVE MATERIALS
  handling and storage of, design of equipment for, 25:57719(P)
  radiography of, design and operation of equipment for x-ray, 25:57688
  radiography of, equipment and method for underwater cold-neutron, 25:57679(T) (LB/G-2986)
  shipping by rail or motor vehicle, US Dept. of Transportation regulations for, 25:57710
  shipping of, design modification of ATMX-500 railroad car for, 25:57705 (MLM-1812)
  shipping through UK ports, standard for safe, 25:57711
  standard for sampling of airborne, in nuclear facilities, 25:57712
  standards for shipping by railway in UK, 25:57713
RADIOACTIVE MINERALS
  prospecting for, radiometric instruments for, 25:57867
RADIOACTIVE WASTE
  analysis for plutonium, computer-controlled system for, 25:57897
  analysis in large and small containers using mobile assay system, 25:57704 (GULF-RT-A-10826)
  analysis of aqueous, for uranium, spectrophotometric, 25:57343
  concentration device for liquid, continuous, 25:57900(P)
  disposal into sea, equipment and method for in-situ monitoring of seabed gamma activity from, 25:57586
  disposal into sea, IAEA panel recommendations on, 25:57708
  disposal of fuel reprocessing plant, using underground nuclear chimneys, 25:57604 (UCRL-73130)
  disposal of reactor cooling water-contained, into Columbia River, effects on radioisotope content of river sediments and waters, (E), 25:57561 (TID-25786)
  effects on environment of U.S. of power reactor, 25:60001
  effects on environment of U.S. power reactor, 25:60002
  processing alpha-emitting, combined flocculation and ion exchange method for, 25:57998 (NIRS-Pu-8)
  processing and disposal of solutions or suspensions of, using film-forming and binding agents, 25:57531
  processing and disposal of, in Federal Republic of Germany, 25:57540
  processing of liquid, from radiological institutes, 25:57529
  processing of low-level liquid, at West Valley Processing Plant, technical specification for facility for, 25:57512 (DOCKET-50201-87)
  radiolysis of liquid, during bedrock storage, self-, 25:57459 (DP-1264)
  separation of alpha and beta sources from, by coagulation with ferric hydroxide, 25:57556

- separation of plutonium from incinerator ash, evaluation of methods for, 25:57525 (RFP-1723)
- shipping to Lyons, Kansas, thermal cooling method for containers and shielding for, 25:57706 (ORNL-TM-3545)
- storage at French nuclear center in Hague, relation of medical problems of personnel to, 25:57978
- storage of phosphate glass-incorporated, in stainless steel pot under water, semi-fluid conditions in, 25:57702 (BNWL-B-112)

RADIOACTIVITY
- conference on monitoring of, in atmosphere, Obninsk, July 30 to Aug. 2, 1968, 25:57576
- measurements in sediments at base of Mt. Obora, Japan, 1967, 25:57566
- monitoring in airborne dusts over the Netherlands during 1967, 25:57575 (RA-42)
- monitoring in vicinity of Savannah River Plant during January through June 1971, 25:57996(R) (DPSPU-71-30-16)

RADIOAPPLICATORS
- radiation dose rate from cobalt-60 gamma, performance of rate meters for measurements of, 25:58010

RADIOCHEMICAL PROCESSING PLANTS
- development of Elan-2B, for preparation of cesium-137 and strontium-90 sources, 25:57482(T) (ORNL-tr-2535)
- equipment decontamination for, remote, 25:57517 (DP-1266)
- nuclear materials control systems for, standards for, 25:57717
- waste disposal from fuel, using underground nuclear chimneys, 25:57604 (UCRL-73130)

RADIOFREQUENCY SPECTROMETERS
- data acquisition and control system for NMR, on-line computer, 25:57887

RADIOGRAPHY, BIOMEDICAL
- effectiveness for diagnosis of tumors of human liver, 25:58044
- effectiveness of lipiodol contrast media, for localization of neoplasms of human lymph system in comparison with radioisotope scanning, 25:58055
- fundamentals of tomographic, using automatic exposure techniques, 25:58066

RADIOGRAPHY, INDUSTRIAL
- development of neutron, for inspecting mixed-oxide fuels, use of radiographic analogues in, 25:57698
- development of neutron, for welded joints in reactors, 25:57680 (ORNL-TM-3561)
- equipment and method for underwater cold-neutron, of radioactive objects, 25:57679(T) (LB/G-2986)
- equipment for x-ray, of radioactive objects, design and operation of, 25:57688
- equipment for, design of, 25:57889(P)
- films for neutron, performance of Polaroid Types 52 and 57, 25:57691
- gamma buildup in, analytical method for evaluation of, 25:57681
- method for identifying defects in steel castings up to 2 in. thick, standard reference radiographs for use in, 25:57694
- method for identifying defects in steel fusion welds, standard reference radiographs for use in, 25:57687
- method for inspecting thick castings and welds, use of betatron in, 25:57678 (INR-1204)
- method for thin welded joints using beta particles, 25:57700
- methods for measuring dynamic conditions inside aircraft gas turbine engines, 25:57689
- quality control in gamma, efficiency evaluation of method for, 25:57656
- radioisotope sources for gamma, method for determining optimum life of, 25:57697
- screens for high energy, evaluation of metal intensifying, 25:57690
- standard for controlling quality of, 25:57682
- standard reference radiographs for heavy-walled steel castings, 25:57684
- standard reference radiographs for steel welds, 25:57683

RADIOIMMUNOASSAY
- method for antibodies to virus antigens, 25:57912
- method for growth hormone in dog plasma, 25:57909
- method for measurement of epinephrine and norepinephrine content in blood plasma, double isotope, 25:57914

RADIOISOTOPE SCANNERS
- collimators for use with low-energy radioisotopes, 25:57891
- design of tomographic, 25:57754(P)
- development of self-triggered wire spark chambers as, 25:57784
- performance for detection of carbon-14-labeled compounds, 25:57752

RADIOISOTOPE SCANNING
- book: Handbook for Technologists of Nuclear Medicine, 25:58049
- contrast intensification during, use of television reproduction for, 25:58059
- data processing using desk-top computers, 25:58065
- distribution data for quantitative, statistical analysis of, 25:58062
- effectiveness for diagnosis of tumors in human liver, 25:58044
- effectiveness for localization of neoplasms of human lymph system in comparison with radiography, 25:58055
- evaluation of rectilinear and dual probe, for diagnostic studies in man, 25:58057
- method using neutron activation analysis in vivo, 25:57785
- scan image quality for, statistical evaluation of, 25:58067

RADIOISOTOPES
- book: Isotopes: Bibliographies and Reference Tables. Volume III, 25:59697
- content in Columbia River water, relations with chemical, mineral, and physical characteristics of streambed sediments, (E), 25:57561 (TID-25786)
- content in Indian soils, gamma spectrometric measurements of, 25:57567
- content of environment and foodstuffs in relation to man, 25:57994
- content of foods in Kiev region of Soviet Union, 25:57987
- decay of, tables of gamma spectra from, 25:59785
- detection of low-energy, silicon avalanche detector for in vivo, 25:57770
- handling of, standard for safe, 25:57709
- hazards to man in industry and medicine, 25:58139
- preparation of radiation targets of, methods for, 25:59635 (CONF-711002-, pp 91-100)
- production of gaseous, from neutron-irradiated targets, 25:57485(P)
- regulatory control of accelerator-produced, in USA during 1969, 25:58028 (BRH/DMRE-71-4)
- separation by chemical and nuclear methods, 25:57521 (KURRI-TR-76, pp 15-18)
- separation from radiation targets, chemical and nuclear methods for, 25:57481 (KURRI-TR-76, pp 8-14)
- separation using laboratory-type electromagnetic separator, 25:57649 (CONF-711002-, pp 1-9)
- transport in SNAP-8 cooling system, 25:58166(R) (AI-AEC-12980)
- transport through ecosystems, use of biological models and computer calculations in studies of kinetics of, 25:57947 (CONF-710501-35)
- uptake and retention in human tissues, development of radiation protection standards from data on, 25:58024 (CONF-711104-1)
- use as gamma sources in radiography, optimum lifetime for, 25:57697
- use as tracers for measuring thermal expansion and wear of turbine components, 25:57663
- use in agriculture in Hungary, 25:57911
- uses in food science and technology, review on tracer, 25:57913
- uses in railway transportation industry, 25:57672

RADIOMETRIC TESTING
- performance of gamma-scintillation, for detecting material defects, effects of noise level and source characteristics on, 25:57701

RADIOTHERAPY
- dose curves for, real-time computer system for calculation and display of, 25:58078
- dose distribution planning for megavolt, use of computers in, 25:58007
- effectiveness of high-energy beam, dosimetry and energy studies related to, 25:58075
- tumor treatment by, performance of Hiedelberg Triga reactor for, 25:60173

RADIUM
- activity in nonequilibrium state, gamma spectrometric measurement of, 25:57506
- effectiveness of intracavitary, for therapy of uterine cervical carcinomas, 25:58070
- effects on human epithelium following therapy for cervical tumors in relation to recurrance incidence, cytological and histological studies on, 25:58140
- electromigration behavior of, in CDTA and EDTA, 25:57520 (JINR-E6-5952)
- precipitation with bone mineral analog calcium hydroxylapatite by isomorphous cocrystallization, 25:57418
- preparation of targets of, by vacuum evaporation, 25:59638 (CONF-711002-, pp 116-21)
- regulatory control of, in USA during 1969, 25:58028 (BRH/DMRE-71-4)

RADIUM ISOTOPES Ra-224
- effects on incidence of osteosarcomas in beagle dogs following intravenous injection, 25:57918

RADIUM ISOTOPES Ra-226
- activity in nonequilibrium state, gamma spectrometric measurements of, 25:57365
- determination in presence of bismuth-214 and lead-214 by gamma spectrometry, 25:57365
- determination in urine, methods used at CNEN for, 25:57347 (RT/PROT-(71)9)
- effects on incidence of osteosarcomas in beagle dogs following intravenous injection, 25:57918
- excretion and retention time in man following acute or chronic intake, method for calculation of, 25:57919
- radon leakage from sealed sources of, photographic method for detection of, 25:57707

RADIUM ISOTOPES Ra-228
- effects on incidence of osteosarcomas in beagle dogs following intravenous injection, 25:57918

  - effects on oxidative phosphorylation in rat tissues, 25:57932
  - leakage from sealed radium source, photographic method for detection of, 25:57707
- RADON ISOTOPES Rn-222
  - distribution on Moon surface, uniform and pile-up, (E/T), 25:58680
- RAINWATER
  - cerium-144 content of Fayetteville, Arkansas, from May 1966 to Jan. 1969, 25:57578
- RANCHO SECO POWER REACTOR
  - construction of, request for not suspending permit for, 25:59971 (DOCKET-50312-26)
- RARE EARTH ISOTOPES
  - cross section measurements of, nondestructive and destructive methods of analysis used in fabrication of targets for, 25:57345 (CONF-711002-, pp 293-306)
- RARE EARTH MINERALS
  - analysis of concentrates of, for yttrium by neutron activation, 25:57382
- RARE EARTH OXIDES
  - analysis for impurities, polarographic, 25:57311
  - analysis for thorium and uranium by TBP extraction and photometry, 25:57341
- RARE EARTHS
  - analysis for yttrium by extraction chromatography and emission spectroscopy or neutron activation, 25:57372
  - determination by differences in rates of substitution reactions in complexes with polydentate ligands, 25:57319
  - determination in mixed oxide fuels, method for, 25:58344(R) (LA-4693)
  - determination using terbium complex with 1,2-dihydroxybenzene-3,5-disulfonic acid as luminescent indicator, microvolumetric, 25:57317
  - separation by electrophoresis in Complexon III on cellulose or silica gel, 25:57299
  - separation by high-pressure liquid chromatography using α-hydroxyisobutyric acid as eluant, 25:57526 (UCRL-73190(Rev.1))
  - separation from MSBR fuel by extraction, 25:57298 (ORNL-4676, pp 73-138)
  - separation from MSBR fuel by extraction using liquid metals, 25:57522 (ORNL-4676, pp 234-71)
  - separation from plutonium by solvent extraction using TBP, 25:57357
  - separation from thorium and uranium by solvent extraction using TBP, 25:57341
  - separation from thorium by ion exchange, 25:57342
- RARE GASES
  - determination of radioactive, released from fuel elements by gas chromatography and γ spectrometry, continuous, 25:57344 (CEA-R-4218)
  - deuterium-hydride scattering at 300 to 3500 m/sec by, total effective cross sections for, (E), 25:58781
  - diffusion and release from uranium dioxide, review of, 25:58413
  - hydrogen-atom reactions with, review of charge exchange in, (E), 25:58743
  - proton reactions with, review of charge exchange in, (E), 25:58743
  - release during annealing of ion-bombarded solids, review of, 25:58412
- RATS
  - californium-252 distribution, excretion, and retention by, following intraperitoneal injection, 25:57922
  - effects of gamma processed fish on, following ingestion over three generations, 25:58162
  - nitrogen content of blood of, following administration of mercuric bichloride and uranium, 25:58099
  - plutonium-239 distribution in, whole-body autoradiographic method for measurement of, 25:57998 (NIRS-Pu-8)
  - plutonium-239 excretion by, effects of dehydrocholic acid, DTPA, and pilocarpine on enhancement of, 25:57998 (NIRS-Pu-8)
  - radiation dose to, effectiveness of blood plasma-quenching effect for measuring whole-body γ, 25:58017
  - radiation effects on aminotransferase activity in mitochondria of tissues of, x, 25:57933
  - radiation effects on behavior and thyroid gland of, following intraperitoneal injection of iodine-131 during gestation, 25:58100
  - radiation effects on central nervous system of, review of research on, 25:58143
  - radiation effects on cholinesterase and hexokinase activity in brain and heart of, effects of adrenal hormones on x, 25:57929
  - radiation effects on leukocyte count, adrenal cortex, and thyroid of, bremsstrahlung, 25:58107
  - radiation effects on liver cells in, mechanism for x, 25:58130
  - radiation effects on medullary tissue of brain of, electron microscopy of γ, 25:58118
  - radiation effects on mitotic activity in bone marrow cells of, effects of species on x, 25:58116
  - radiation effects on numbers of cysteine-rich glial cells in brain of, effects of dose and head exposure on x, 25:58106
  - radiation effects on orthodromic responses of, following exposure of spinal cord, x, 25:58101
  - radiation effects on oxidative phosphorylation in tissues of, radon, 25:57932
  - radiation effects on phosphorus-32 uptake by bone marrow, liver, and spleen of, effects of bone marrow transplants on x, 25:58123
  - radiation effects on tibia of, comparison of effects of dose on γ and x, 25:58102
  - radioinduced lesions in blood, bone marrow, and lungs of, similarity between lesions induced by vaccinal disease and, 25:58128
  - radioinduced neoplasms in, relation of age and sex to incidence of x, 25:58097(T) (ORNL-tr-2521)
  - redox potential in muscles of, effects of cystamine on, 25:58031
- REACTIVITY
  - shutdown margins for, two frequency reactor noise method for worth measurements for, (T), 25:60043
- REACTOR CONTAINMENT STRUCTURES
  - aerosols in liquid metal cooled fast reactor, distribution of accident released, (E/T), 25:60148 (AI-69-Memo-95)
  - air locks for, coupled fastening mechanism for door pairs of, 25:60257(P)
  - design characteristics of earthquake resistant floating, for power reactors, 25:60091(P)
  - design characteristics of prestressed concrete, 25:60256(P)
  - design of aircraft, impact speed and angle criteria for, 25:60192 (N-71-25411)
  - design parameters for liquid sodium cooled fast test reactor, 25:60188
  - fission product deposition in, effects of heat transfer characteristics on, (T), 25:60111(R) (BMI-1917)
  - leak rate test for pressurized water power reactor, 25:60000
  - spray systems for pressurized water reactor, development of fission product removing, 25:60086
  - stress loading requirements for liquid sodium cooled fast test reactor, 25:60188
- REACTOR CONTAINMENT SYSTEMS
  - filter systems for, methyl iodide removal efficiency of activated carbon, (T), 25:60088
  - fission product removal by ice condenser, effects of absorbent solutions in ice cubes on, (E), 25:60124
- REACTOR CONTROL ELEMENTS
  - drive motor for drum type, performance of electric stepping, (T), 25:60193 (N-71-26979)
  - drive system for pressurized water, design of solid-state, 25:60066
  - drive system for, design of hydraulic, 25:60047
  - handling of liquid metal cooled fast, gripping device for, 25:60259(P)
  - location in fast reactor cores, effects on breeding ratio and fuel temperature of, (T), 25:60045
  - movement programming of boiling water, effects of refueling schemes on optimum, (T), 25:60101
- REACTOR CONTROL SYSTEMS
  - design characteristics for neutron flux monitoring automatic, 25:60054(P)
  - design for automatic startup and power regulation, 25:60169
  - design modifications for power reactor, 25:59899
  - design with fine flux trim rods to eliminate hot channels, 25:60244(P)
  - development of automatic, for gas cooled power reactors, 25:59894
  - development of on-line digital computer, for research reactor, 25:60185
  - stability of closed-loop, root locus method for analysis of, 25:60219
  - stability of separate dual, for coupled core reactors, (T), 25:60051
- REACTOR EXPERIMENTAL FACILITIES
  - performance of semiautomatic pneumatic shuttle system for water cooled and moderated research reactors, 25:60168
- REACTOR FUEL ELEMENTS
  - cladding failures in sodium bonded, sodium soluble isotopic tagging methods for location of, (T), 25:60083 (ANL-7785)
  - cladding for, closed-end burst testing of, 25:58209 (AECL-3992)
  - cladding materials for fast breeder, development of, (E/T), 25:60010(T) (EURFNR-902)
  - cladding tubes for, deformation and rupture behavior of Zircaloy-4, (E), 25:60118 (ORNL-4727)
  - coating cracks in Rover, masked probe for detection of, 25:57659
  - design criteria for stainless steel-clad ceramic pin-type, for 1000 MW(e) breeder reactor, 25:58410 (BLG-456)
  - design of assemblies with radially varying plutonium and uranium contents, 25:60247(P)
  - design of gas cooled, with means for prevention of vibrations, 25:60084(P)
  - design of thermionic, with heat pipes, 25:60199(P)
  - design of tubular, with means for expansion between internal and external cladding, 25:60250(P)
  - design with cup-shaped retainer between fuel and fission gas plenum, 25:60246(P)
  - design with helical metal strip wrapped around pin clusters, 25:60253(P)

- development of fast breeder, fabrication and irradiation testing programs for, 25:60010(T) (EURFNR-902)
- end fitting for, design of latch and pad assembly for, 25:60252(P)
- end fitting for, design of solid cylindrical, 25:60251(P)
- fabrication of hexagonal thorium--uranium, for unclad metal breeder reactor, 25:58185 (ORNL-TM-3499)
- fabrication of, method for, 25:58355(P)
- failure detection and identification of fast, methods for leaking, 25:60082 (ANL-7782)
- failure of liquid sodium cooled, effects on coolant boiling of, 25:60117 (KFK-1380)
- failure of sodium cooled, development of methods for detection of, 25:60058(R) (ANL-7817)
- failure of water cooled rod type, analysis of accident propagation from, 25:60126
- fission density distribution in uranium oxide (UO_2) rod type, autoradiography analysis of, 25:60172
- fission gas release from, continuous measurement of rare gas, 25:57344 (CEA-R-4218)
- heat transfer characteristics of water cooled Zircaloy clad bundles of pin type, during coolant loss accident conditions, (E), 25:60114 (CONF-711103-1)
- heat transfer crisis in boiling water flowing through bundles of, 25:57638 (IAE-2014)
- heat transfer from tubular, in central channel of natural uranium gas-cooled reactor, (E/T), 25:57639 (JUL-753-RB)
- inspection of rod-type, eddy current method for, 25:57692(P)
- neutron distribution in clusters of rod type, calculation of first flight collision probabilities for, (T), 25:60235
- radiation effects on, limitations of least squares method for determining, 25:58301 (RD/B/N-1971)
- reprocessing of irradiated, continuous head end dissolution method for, 25:57539(P)
- shipping of irradiated clad uranium dioxide, design of container for, 25:57703 (DPSPU-71-124-4A)
- spaces for bundles of rod type, design characteristics of wedge shaped core expanding, 25:60255(P)

REACTOR FUELS
- analysis of irradiated ceramic, for oxygen, method for, 25:58344(R) (LA-4693)
- analysis of irradiated mixed oxide, for sodium, spectrochemical, 25:58344(R) (LA-4693)
- analysis of mixed oxide, for rare earths, method for, 25:58344(R) (LA-4693)
- analysis of mixed oxide, for sulfur, spectrophotometric, 25:58344(R) (LA-4693)
- analysis of solutions of, for added metals, corrosion products, and sulfuric acid, 25:57320
- burnup analysis of JRR-1, 25:57320
- burnup in heavy water reactors, methods for analysis of, (E/T), 25:60093 (AECL-3995)
- burnup of power, economics of, 25:60102
- burnup of, effects of variations in operation periods on, (T), 25:60216
- chemistry of molten salt, 25:57298 (ORNL-4676, pp 73-138)
- cladding failure on, detection by fission-product cesium-137 counting, 25:58344(R) (LA-4693)
- cooling of coated particle, direct method for helium, 25:57645
- cycle analysis for fast breeder, collapsing method effects on spatial mesh data for, (T), 25:60100
- cycle for power reactor, development in Europe of, 25:59901
- cycles for pressurized heavy water power reactors, effects of plutonium recycle on optimum economic, 25:60092 (AECL-3910)
- cycles for water moderated power reactors, linear programming for optimization of, (T), 25:60104
- cycles in Japan power reactors, economic aspects of, 25:59928
- development for use with in-pile chemonuclear loops, 25:57610 (BNL-50293)
- development of fast breeder, fabrication and irradiation testing programs for, 25:60010(T) (EURFNR-902)
- economics of, cost--benefit analysis of, 25:59921
- fabrication of oxide pellet-type, with center holes, pressing and sintering method for, 25:58362
- fission product re-solution rates in, measurement of, 25:58411(R) (GEAP-12217)
- meltdown in TREAT, estimation of total energy for, 25:58344(R) (LA-4693)
- production and processing of, in Federal Republic of Germany, 25:57666
- properties of sintered ceramic, relations with microstructure, 25:58389(R) (SRO-552-8)
- radiation testing of, CNEN summary on methods for, 25:58351 (RT/ING-(70)30)
- reprocessing methods for fast, 25:60005(R) (ANL-7854)
- reprocessing of fast breeder, by Purex Process, separation of plutonium and uranium in, 25:57518(T) (EURFNR-888)
- reprocessing of molten salt, flowsheet analysis for, 25:57522 (ORNL-4676, pp 234-71)
- reprocessing of oxide, liquid-metal head-end process for, 25:57507(R) (ANL-7799)
- reprocessing of pyrocarbon-coated, by chloride extraction process, 25:57542
- reprocessing of Rover, by burn leach method, 25:57519 (IN-1484)
- reprocessing of thorium, with high burnup by Thorex two-stage process, 25:57541
- reprocessing of uranium-containing, solvent extraction method for, 25:57534(P)
- reserves and long-range requirements for, estimates of, 25:60020
- separation of plutonium from LMFBR, development of mixer-settler for, 25:57508 (ANL-7810)
- solubility of irradiated mixed oxide, in hydrochloric acid at high pressures, 25:58344(R) (LA-4693)

REACTOR LOADING MACHINES
- centering device for, design of vertical tubular, 25:60254(P)
- design characteristics of high temperature gas cooled graphite moderated reactor, 25:60031(P)
- design characteristics of liquid sodium cooled fast reactor, 25:60087
- design parameters of liquid sodium cooled fast test reactor, 25:60174

REACTOR MODERATORS
- neutron slowing down times in, effects of pulse shapes on, (T), 25:60232

REACTOR SAFETY
- accidents in, review of U.S. safety programs on, 25:60132
- analysis of, listing of computer programs for, 25:60127
- chemical aspects of, review of, 25:60116 (HMI-B-113)
- reliability engineering methods for, 25:60125
- reliability requirements in evaluation of, 25:60122

REACTOR SAFETY EXPERIMENTS
- operation of TREAT, during August 1971, 25:60005(R) (ANL-7854)
- physics calculations of power distributions in TREAT test fuels, 25:58344(R) (LA-4693)
- reactivity transients in SPERT-III E-core, prompt moderator heating feedback effects on, (E/T), 25:60179

REACTORS
- accidents in, listing of computer programs for analysis of, 25:60127
- book: Nuclear Heat Transport, 25:60222
- conference on radioinduced void formation in materials for, Reading, Eng., March 24 to 25, 1971, 25:58304
- core measurements in, device for magnetic transmission of, 25:60245(P)
- critical size of bare, Lie series method for solution of multi-dimensional multigroup diffusion equation for, 25:60233
- excursions in, model including delayed neutrons for self-limiting, 25:60223 (AD-721076)
- heat flux studies for, critical, (E/T), 25:57647
- integral characteristic of, derivation of neutron production over neutron losses ratio for, 25:60227
- kinetics of, optimum two dimension S/sub N/ calculation methods for, 25:60224(T) (EURFNR-899)
- measurement and control of, development of broadband high-temperature magnetostrictive and piezoelectric ultrasonic transducers for, 25:57898
- neutron collision probabilities in cluster-type fuel lattices in, (T), 25:60231
- neutron diffusion calculations for, self-initializing version of WIGL2 code for, 25:60209 (DUN-7538)
- neutron distribution in thin homogeneous natural uranium slab, synthesis solution of multigroup Boltzmann equation for, 25:60214
- neutron flux in cells of finite square lattices in, source-sink theory analysis of, 25:60228
- noise spectra in, neutron energy effects on, (E/T), 25:60238
- operations incidents in, analysis of reactivity perturbations for detection of, 25:60123
- physics calculations for, use of evolution operator method in, 25:60221
- physics constants for, computer program for calculation of thermal neutron, 25:60225 (JAERI-Memo-4394)
- power change with internal feedback in, methods for space-time optimal, (T), 25:60241
- power distribution in, use of modern control theory for analysis of spatial, 25:60213
- pressure vessels for, use of steel cover on prestressed concrete, 25:60258(P)
- pressure vessels for, with thin steel shells surrounded by metal girders and rings, 25:60070(P)
- protection systems for, design procedure for optimum noise filter for, 25:60248
- safety aspects of, reliability engineering methods for, 25:60125
- shielding for, monitoring system for dosimetry at surfaces of, 25:57779
- stability of, Liapounov method for calculation of, (T), 25:60239
- subcriticality measurements in, optimal filtering method for, (E/T), 25:60234
- transfer functions for, method for calculation of coefficients of, (T), 25:60229
- xenon oscillations in large, calculation of optimum control rod strategy for, (T), 25:60236

REACTORS, AGR-TYPE
- design characteristics of, 25:60030

REACTORS, AIRCRAFT
- containment vessel for, impact speed and angle criteria for design of, 25:60192 (N-71-25411)

REACTORS, BOILING
- control element programming in, effects of refueling schemes on optimum, (T), 25:60101
- coolant loss accidents in, analytical description of, 25:60111(R) (BMI-1917)
- cooling systems for, effects of corrosion on low-cycle fatigue life of piping in, (E), 25:60061(R) (GEAP-10207-24)
- cooling systems for, use of constant speed pumps and feedwater driven pumps in, 25:60067(P)
- hydrodynamics of, design problems for, 25:60065
- pressure vessels for heavy water moderated power, temperature distribution in prestressed concrete, 25:60080
- pressure vessels for heavy water moderated power, thermal stress limits for prestressed concrete, 25:60081
- pressure vessels for, effects of thickness on fracture characteristics of steel, 25:60075
- simulation of, hybrid computer for real time, 25:60218
- stability of, effects of self-oscillation conditions on, (T), 25:60037
- transfer functions for, thermal and hydrodynamic, (E/T), 25:60038

REACTORS, BREEDER
- accidents in, review of U.S. safety programs on, 25:60132
- control element locations in cores of, effects on breeding ratio and fuel temperature of, (T), 25:60045
- cooling systems of, corrosion product and fission product activity levels in, (E), 25:60010(T) (EURFNR-902)
- core design for, with fuel pins containing blanket material in end sections, 25:60028(P)
- core monitoring in, instrumentation and signal processing for, (E/T), 25:60010(T) (EURFNR-902)
- design characteristics of gas cooled fast, in Germany, 25:60013 (KFK-1375)
- design problems with gas cooled fast, 25:60009 (CONF-710922-5)
- design problems with liquid sodium cooled fast, review of, 25:60008 (CONF-710922-4)
- development in Germany during October to December 1970, 25:60010(T) (EURFNR-902)
- development in Germany of liquid metal cooled fast, 25:60012 (JUL-775-RG)
- development of fast, in European Community, 25:60032
- development of gas cooled fast, review of, 25:60009 (CONF-710922-5)
- development of liquid sodium cooled fast power, summary of, 25:60029
- economic aspects of gas cooled fast, in Germany, 25:60013 (KFK-1375)
- fuel cycle analysis for fast, collapsing method effects on spatial mesh data for, (T), 25:60100
- fuel elements for helium-cooled 1000 MW(e), mechanical and thermal properties of, 25:58410 (BLG-456)
- fuel elements for, fabrication of unclad metal, 25:58185 (ORNL-TM-3499)
- physics parameters of, (E/T), 25:60010(T) (EURFNR-902)
- power conversion system for 1000 MW(e) helium cooled fast, design parameters for closed cycle gas turbine, 25:60137 (KFK-1409)
- power shift in sodium cooled fast, effects of long-term operation on, (T), 25:60044
- safety aspects of fast, 25:60136
- safety studies on, (E/T), 25:60010(T) (EURFNR-902)

REACTORS, CANDU-TYPE
- fuel burnup in, methods for analysis of, (E/T), 25:60093 (AECL-3995)
- fuel cycles for pressurized heavy water, effects of plutonium recycle on optimum economic, 25:60092 (AECL-3910)

REACTORS, FAST
- accidents in liquid sodium cooled, effects of fuel element failures and coolant flow blockage on, 25:60117 (KFK-1380)
- accidents in, review of U.S. safety programs on, 25:60132
- construction of sodium cooled, requirements and problems in, 25:60007 (CONF-710922-1)
- control element locations in cores of, effects on breeding ratio and fuel temperature of, (T), 25:60045
- control elements for, gripping device for handling, 25:60259(P)
- coolant boiling in liquid sodium cooled, effects of fuel element failures and coolant flow blockage on, 25:60117 (KFK-1380)
- cooling systems of, corrosion product and fission product activity levels in, (E), 25:60010(T) (EURFNR-902)
- core components for power, effects of radioinduced voids on design of, 25:58331
- core design for, with fuel pins containing blanket material in end sections, 25:60028(P)
- core meltdown accidents in, methods for analysis of mechanical work energy produced during, 25:60121
- core monitoring in, instrumentation and signal processing for, (E/T), 25:60010(T) (EURFNR-902)
- core of, hydrodynamic and thermodynamic design of, (E/T), 25:60010(T) (EURFNR-902)
- design characteristics of gas cooled breeder, in Germany, 25:60013 (KFK-1375)
- design characteristics of liquid sodium cooled, comparison of, 25:60094 (CONF-710922-2)
- design parameters for, methods for optimization of, (T), 25:60217
- design problems with gas cooled breeder, 25:60009 (CONF-710922-5)
- design problems with liquid sodium cooled breeder, review of, 25:60008 (CONF-710922-4)
- development in Germany during October to December 1970, 25:60010(T) (EURFNR-902)
- development in Germany of liquid sodium cooled breeder, 25:60012 (JUL-775-RG)
- development of breeder, in European Community, 25:60032
- development of gas cooled breeder, review of, 25:60009 (CONF-710922-5)
- development of liquid sodium cooled breeder power, summary of, 25:60029
- economic aspects of gas cooled breeder, in Germany, 25:60013 (KFK-1375)
- fission products in, integral measurement of reactivity worths of, (E/T), 25:60034 (AE-428)
- fission products in, reactivity worth measurements for, 25:60159 (RCN-150)
- fuel cycle analysis for breeder, collapsing method effects on spatial mesh data for, (T), 25:60100
- fuel cycles for, calculation of uranium burnup and plutonium buildup in various, 25:60095(R) (IAEA-R-742-F)
- fuel element bundles in gas cooled, heat transfer and fluid flow in, (E/T), 25:60059 (CONF-710606-14)
- fuel elements for, shielded container for shipping of irradiated, 25:57720
- neutron flux and importance spectra in, slowing down theory model for analytic solution of, 25:60211 (RPI-328-189)
- neutron spectra in, synthesis of 50 energy-group, 25:60215
- operating experience with liquid sodium cooled, review of, 25:60094 (CONF-710922-2)
- physics parameters of, (E/T), 25:60010(T) (EURFNR-902)
- physics parameters of, comparison of calculations and integral measurements of, 25:60036 (EURFNR-945)
- physics parameters of, evaluation of neutron cross section sets for analysis of, 25:60210 (JAERI-Memo-4406)
- power conversion system for 1000 MW(e) helium cooled breeder, design parameters for closed cycle gas turbine, 25:60137 (KFK-1409)
- power shift in sodium cooled breeder, effects of long-term operation on, (T), 25:60044
- power transmission systems for, development of underground, 25:60109
- safety aspects of breeder, 25:60136
- safety aspects of liquid sodium cooled, 25:60113 (CONF-710922-3)
- safety studies on, (E/T), 25:60010(T) (EURFNR-902)
- shutdown margins for, two frequency reactor noise method for worth measurements for, (T), 25:60043
- transients in sodium cooled, multigroup spatially dependent analysis of mild, 25:60237

REACTORS, GAS-COOLED
- accidents in high temperature power, review of U.S. safety programs on, 25:60130
- control systems for, design characteristics of neutron flux monitoring automatic, 25:60054(P)
- coolant flow patterns for direct cycle gas turbine, control system for core by-pass, 25:60073(P)
- cooling systems for high temperature, heat transfer and fluid flow characteristics of, 25:60076
- design characteristics of fast breeder, in Germany, 25:60013 (KFK-1375)
- design characteristics of high temperature, 25:60030
- design parameters of 50 MW(t) experimental high temperature helium cooled, 25:60011 (JAERI-Memo-4419)
- design problems with fast breeder, 25:60009 (CONF-710922-5)
- design with direct cycle carbon dioxide turbines, 25:60016(P)
- design with direct cycle gas turbine and secondary indirect cycle turbine, 25:60027(P)
- development of fast breeder, review of, 25:60009 (CONF-710922-5)
- development of high temperature, for process heat production, 25:60202
- development of high temperature, in Germany, 25:60012 (JUL-775-RG)
- economic aspects of fast breeder, in Germany, 25:60013 (KFK-1375)
- fuel cycles for high temperature, economics of plutonium, 25:60097 (ORNL-TM-3525)
- fuel element bundles in fast, heat transfer and fluid flow in, (E/T), 25:60059 (CONF-710606-14)
- fuel elements for, method for fabrication of, 25:58355(P)
- fuel elements for, with means for prevention of vibrations, 25:60084(P)
- fuels for helium-cooled, direct cooling method for, 25:57645
- heat exchangers for, design characteristics of secondary, 25:60074(P)

  loading machine for high temperature graphite moderated, 25:60031(P)
  maintenance of, design requirements for access and inspection for, 25:60026
  power conversion system for 1000 MW(e) fast breeder, design parameters for closed cycle gas turbine, 25:60137 (KFK-1409)
  power conversion system for power, description of closed cycle gas turbine, 25:60141(P)
  power conversion system for, operating characteristics of secondary air cooling system with closed Brayton cycle gas turbines, 25:60140
  power conversion system for, performance of combined closed cycle helium gas turbine and Rankine steam cycle for, 25:60139
  safety aspects of high temperature power, 25:60130
  shutdown of high temperature, afterheat removal system for, 25:60110
  turbines for helium cooled, design problems of direct cycle, 25:60145
REACTORS, GRAPHITE-MODERATED
  loading machine for high temperature gas cooled, 25:60031(P)
REACTORS, GREAT BRITAIN
  development of power, 25:60030
  maintenance of power, review of in-pile, 25:59925
REACTORS, HEAVY WATER-MODERATED
  design of water cooled pressure-tube, with increased core power density, 25:60033(P)
  development of, status of, 25:60019
  materials for, properties of zirconium alloy, 25:58217 (ZJE-107)
  pressure vessels for boiling power, temperature distribution in prestressed concrete, 25:60080
  pressure vessels for boiling power, thermal stress limits for prestressed concrete, 25:60081
  steam generators in pressurized water, core configuration and piping system for, 25:60146(P)
REACTORS, JAPAN
  materials for, development of, 25:58194
REACTORS, LIQUID METAL-COOLED
  accidents in fast, effects of fuel element failures and coolant flow blockage on, 25:60117 (KFK-1380)
  accidents in, review of U.S. safety programs on, 25:60132
  aerosol distribution in containment of, following accidental reactor vessel rupture, 25:60148 (AI-69-Memo-95)
  construction of sodium cooled, requirements and problems in, 25:60007 (CONF-710922-1)
  control elements for, gripping device for handling, 25:60259(P)
  coolant boiling in fast, effects of fuel element failures and coolant flow blockage on, 25:60117 (KFK-1380)
  coolant boiling in liquid sodium cooled, stable and transient flow characteristics for, 25:60112 (CEA-CONF-1797)
  cooling system for sodium, evaluation of steel intermediate heat exchanger for, 25:57614 (KFK-1387)
  cooling systems for, design characteristics and variations for, 25:60060(T) (EURFNR-904)
  core meltdown accidents in, methods for analysis of mechanical work energy produced during, 25:60121
  core vessels for sodium cooled, sealing means for rotatable covers on, 25:60021(P)
  design characteristics of fast, comparison of, 25:60094 (CONF-710922-2)
  design problems with fast breeder, review of, 25:60008 (CONF-710922-4)
  development in Germany of fast breeder, 25:60012 (JUL-775-RG)
  development of fast breeder power, summary of, 25:60029
  operating experience with fast, review of, 25:60094 (CONF-710922-2)
  power shift in sodium cooled breeder, effects of long-term operation on, (T), 25:60044
  safety aspects of fast, 25:60113 (CONF-710922-3)
  shutdown margins for, two frequency reactor noise method for worth measurements for, (T), 25:60043
  simulation of, hybrid computer for real time, 25:60218
  transients in sodium cooled, multigroup spatially dependent analysis of mild, 25:60237
REACTORS, MAGNOX
  design characteristics of, 25:60030
  operations aspects of, 25:60030
REACTORS, MARITIME
  book: Constructional Features of Nuclear-Powered Vessels, in Russian, 25:60204
  development of, data summary on, 25:60207
REACTORS, MOLTEN-SALT
  design parameters of 300 MW(e) demonstration, 25:60015 (ORNL-4676, pp 21-72)
  development during September 1970 through February 1971, 25:60014(R) (ORNL-4676)
  maintenance of, development of remote welding for, 25:60015 (ORNL-4676, pp 21-72)
REACTORS, POWER
  accidents in 1000 MW(e) pressurized water, comparison of economic and biological risk for design basis, 25:60003
  accidents in high temperature gas cooled, review of U.S. safety programs on, 25:60130
  accidents in water cooled, review of U.S. safety programs on, 25:60131
  accidents in, computer program calculations for secondary events in fault tree analysis of, 25:60134
  accidents in, fault tree analysis of, 25:60133
  containment structures for, design characteristics of earthquake resistant floating, 25:60091(P)
  control of, review of automation in, 25:60048
  control systems for coupled core, stability of separate dual, (T), 25:60051
  control systems for, design characteristics of neutron flux monitoring automatic, 25:60054(P)
  coolant flow control in fuel channels of, description of valve regulated ball closure system for, 25:60072(P)
  cooling system for, finite element method for stress analysis of, 25:60142
  core components for fast, effects of radioinduced voids on design of, 25:58331
  decontamination of, procedures and requirements for, 25:60099
  design characteristics of, 25:59915
  design parameters of 50 MW(t) experimental high temperature helium cooled, 25:60011 (JAERI-Memo-4419)
  development for spacecraft electric power systems, review on, 25:57671
  development in Germany of, 25:60012 (JUL-775-RG)
  development in U.K, 25:60030
  development of worldwide, effects of electric power demands on, 25:59898
  development of dual purpose desalination, 25:60201
  development of heavy water moderated, status of, 25:60019
  development of liquid sodium cooled fast breeder, review of, 25:60029
  development of, changes in national programs for, 25:60024
  dynamics of, calculation of space dependent, (T), 25:60240
  economics in mixed systems, strategies for optimization of, (T), 25:60103
  effluents from U.S., effects on environment of radioactive and thermal, 25:60002
  effluents from U.S., effects on environment of radioactive and thermal, 25:60001
  fuel burnup in, economics of, 25:60102
  fuel cycle costs for water moderated, linear programming for optimization of, (T), 25:60104
  fuel cycles for high temperature gas cooled, economics of plutonium, 25:60097 (ORNL-TM-3525)
  fuel cycles in Japan, economic aspects of, 25:59928
  fuels for, cost--benefit analysis of, 25:59921
  maintenance of gas cooled, design requirements for access and inspection for, 25:60026
  maintenance of, conference on remote, 25:60106
  maintenance of, health physics control during, 25:59926
  maintenance of, tools and recovery equipment for remote, 25:60107
  operation aspects of, 25:59915
  operation before refueling of pressurized water, economic aspects of low power, 25:60098
  operation of U.S., availability and reliability data for, 25:59918
  operation of, stability of nuclear and conventional plant systems in, 25:60105
  operations aspects of dual purpose desalination, analysis of nominal and partial load, 25:60201
  physics calculations for, 25:59915
  physics parameters of CIRENE, review of heterogeneous methods for calculation of, 25:60040
  power conversion system for 1000 MW(e) helium cooled fast breeder, design parameters for closed cycle gas turbine, 25:60137 (KFK-1409)
  power conversion system for gas cooled, description of closed cycle gas turbine, 25:60141(P)
  power conversion system for gas cooled, performance of combined closed cycle helium gas turbine and Rankine steam cycle for, 25:60139
  power conversion system for, finite element method for stress analysis of, 25:60142
  power conversion systems for gas cooled, operating characteristics of secondary air cooling system with closed Brayton cycle gas turbine, 25:60140
  power transmission systems for fast, development of underground, 25:60109
  pressure vessel for, design characteristics of rock shaft mounted prestressed concrete, 25:60071(P)
  pressure vessels for heavy water moderated boiling, thermal stress limits for prestressed concrete, 25:60081
  pressure vessels for heavy water moderated boiling, temperature distribution in prestressed concrete, 25:60080
  pressure vessels for, steel rope wrapping method for prestressing concrete for, 25:60063
  protection system for, calculation of optimum testing schedules for, 25:60053
  protection system for, sensitivity analysis of two-out-of-four coincidence logic, 25:60052
  protection systems for, description of data acquisition and processing equipment and procedures for, 25:60208
  pumps for, computer program for vibrational analysis of,

25:60057 (AECL-3994)
  radiation monitoring in, development of engineered systems for, 25:60120
  safety aspects of high temperature gas cooled, 25:60130
  safety aspects of U.S, 25:60002
  safety aspects of U.S, 25:60001
  safety aspects of water cooled, 25:60131
  safety aspects of, systematic hazards analysis for design and evaluation of, 25:60135
  safety of, reliability requirements in permissible risk evaluation of, 25:60122
  shielding for, temperature distribution in concrete, 25:60056
  structures for, finite element method for stress analysis of, 25:60142
  thermionic converter cells for space, use of reflectors and vapor chamber condensers in, 25:60197(P)
REACTORS, PRESSURIZED-WATER
  accidents in 1000 MW(e), comparison of economic and biological risk for design basis, 25:60003
  containment structures for, development of spray systems for removal of fission products from, 25:60086
  control elements for, solid-state drive system for, 25:60066
  coolant loss accident conditions in, heat transfer characteristics of Zircaloy clad bundles of fuel pins during, (E), 25:60114 (CCNF-711103-1)
  coolant loss accidents in, analytical description of, 25:60111(R) (BMI-1917)
  cooling systems for, corrosion product contamination in and removal from, 25:60068
  cooling systems for, use of sensitized stainless steel in, (E), 25:59886 (WCAP-7735)
  fuel pins for, effects of coolant loss accident conditions on heat transfer characteristics of Zircaloy clad bundles of, (E), 25:60114 (CONF-711103-1)
  operation before refueling of, economic aspects of low power, 25:60098
  operation of, stability of nuclear and conventional plant systems in, 25:60105
  pressure vessels for, effects of thickness on fracture characteristics of steel, 25:60075
  steam generators for, design of compact, 25:60144(P)
  steam generators in heavy water moderated, core configuration and piping system for, 25:60146(P)
REACTORS, PROCESS HEAT
  development of dual purpose desalination and power, 25:60201
  development of high temperature gas cooled, 25:60202
  operations aspects of dual purpose desalination and power, analysis of nominal and partial load, 25:60201
  use for iron and steel production, 25:60200
REACTORS, RESEARCH
  control system for University of Missouri Research Reactor, development of on-line digital computer, 25:60185
  control system for, design of automatic startup and power regulation, 25:60169
  cooling system filters for EWA-10, design parameters and performance of, 25:60157 (INR-1316)
  core design of FR-3, 25:60010(T) (EURFNR-902)
  core materials for, review of absorbed dose determination in, 25:60160 (STI/DCC-10/127)
  development of SORA, 25:60178
  dynamics of TRIGA Mark II, effects of temperature feedback on, (E/T), 25:60164
  experimental facilities for WWR type, performance of semiautomatic pneumatic shuttle system for, 25:60168
  fuel elements of WWR, autoradiography analyis of fission density distribution in uranium oxide (UO_2) rod type, 25:60172
  gamma field intensity in core of EWA-10, 25:57875 (INR-1319)
  neutron beam port of Cornell University TRIGA, tailoring of spectra in, (E), 25:60163
  operation of Heidelberg TRIGA, review of, 25:60173
  performance of various types, criteria for comparison of, 25:60167
  reactivity of IGR, calculation and characteristics of integral, (T), 25:60171
  reactivity of water reflected TRIGA Mark 3, effects of kinetic distortion factor on calculation of, (E/T), 25:60162
  scram of Rossendorf WWR-SM, safety rod movement during, (E), 25:60165
REACTORS, ROCKET
  economics of reusable nuclear shuttle, for interorbital space missions, 25:60198
  nozzles for gas-core, induction plasma testing of designs for, 25:57640 (N-71-22591)
REACTORS, SUPERHEATING
  control elements for, hydraulic drive system for, 25:60047
  steam generators in, core vessel arrangement for, 25:60147(P)
REACTORS, THERMAL
  fuels for, utilization of plutonium, 25:60249
REACTORS, WATER-COOLED
  accidents in power, review of U.S. safety programs on, 25:60131
  control elements for, hydraulic drive system for, 25:60047
  control rod dropout accidents in, transient response following, (T), 25:60111(R) (BMI-1917)
  coolant loss accident conditions in, fuel element failure from, 25:60126
  coolant loss accidents in, design parameters of scale model facility for analysis of, 25:60111(R) (BMI-1917)
  coolant loss accidents in, ECCSA and MUCHA codes for thermal--hydraulic analyses of, 25:60111(R) (BMI-1917)
  coolant of, analysis of distillation methods for purification of primary, 25:60064
  cooling channels of, power spectral density of temperature fluctuations in, (E), 25:60242
  cooling systems for, failure mechanisms in piping of, (E/T), 25:60061(R) (GEAP-10207-24)
  cooling systems for, use of constant speed pumps and feedwater driven pumps in, 25:60067(P)
  design of heavy water moderated pressure-tube, with increased core power density, 25:60033(P)
  emergency core cooling systems for, linearized-implicit formulation of fluid flow model for, 25:60111(R) (BMI-1917)
  fuel element cladding tubes for, deformation and rupture behavior of Zircaloy-4, (E), 25:60118 (ORNL-4727)
  fuel elements of, accident propagation from failure of Ziracloy clad rod type, 25:60126
  neutron flux measurement in, design of fission chamber for, 25:60046
  pressure vessels for, means for uniform stress distribution in prestressed concrete, 25:60069(P)
  safety aspects of power, 25:60131
  structural materials for, γ heating of, (E/T), 25:60022
REACTORS, WATER-MODERATED
  control element programming in, effects of refueling schemes on optimum, (T), 25:60101
  fuel cycle costs for, linear programming for optimization of, (T), 25:60104
  kinetic parameters of natural uranium fueled, pulsed source technique measurements of, (E/T), 25:60166
  materials for, properties of zirconium and Zircaloy structural, 25:58243
  moderator for, γ heating of, (E/T), 25:60022
RECOILS
  reactions in radiation targets in separation of short-lived radioisotopes, 25:57481 (KURRI-TR-76, pp 8-14)
  reactions of, 25:57442
REFRACTORY MATERIALS
  abrasion resistance of, comparison of gas-borne corundum and diamond wheels for testing, 25:58386
  thermal shock resistance of, method for statistical determination of, 25:58376
REFRIGERATION
  description of miniature closed-cycle cooler for accelerator-produced radiation effects in solids down to 20^{o}K, 25:59160
REGGE POLE THEORY
  amplitudes in multi-, factorization into signature terms of, 25:59611
  analysis of glory scattering in backward elastic alpha scattering by spinless nuclei, 25:59846
  cuts in scattering amplitudes at high energies in, selection rules for, 25:59440
  duality in deep inelastic e + p interactions in, field theory for, 25:59363
  duality in K + N interactions, empirical analysis of differences and sums of angular distributions for, 25:59477
  meson (π) conspiracy models in, phenomenological analysis of, 25:59429
  model for particle interactions at intermediate energies, equivalence of optical model and, 25:59421 (COO-2009-30)
  properties of complex poles for bosons, 25:59434
  Reggeon cuts in $\pi + \pi$ and $K^- + p \to K^+ + \Xi^-$ interactions at high energies, two-, 25:59618
  Reggeon exchange contribution to strong interaction amplitudes at high energies, two-, 25:59618
  review on, 25:59425
  scattering in, short-wavelength, 25:59615
  trajectory classification and behavior for π, 25:59460
  trajectory with finite asymptotic phase for resonances, 25:59451
RELATIVITY THEORY
  Boltzmann equation in general, Cauchy problem for, 25:59594
  Carnot cycles in general, (T), 25:58673
  Cauchy problem for nonlinear Boltzmann equation in general, 25:59594
  conference on statistical thermodynamics in, Cardiff, Wales, 4/70, 25:58670
  cosmological constant in general, (T), 25:58661
  Einstein equations in space with nonriemannian connection in general, trajectories in, 25:59598
  Einstein field equations in general, generalization of, 25:59591
  Einstein field equations in general, matter distributions of radial symmetry in solutions of, 25:59597
  ensemble versus time average probabilities in, (T), 25:59238
  equations of motion for test particle in, differential Lie equations for covariant, 25:59584
  field equations in general, dynamical variables in

- canonical form of, 25:59592
- formalism for general, classical gravitational field theory comparison with Newman--Penrose, 25:59593
- formalism for general, supplementary trivial equations in Newman--Penrose, 25:59586
- Lagrangians in general, solutions of equations with quadratic, 25:59603
- Minkowski space--time in, continuous-medium deformation field in, 25:59562
- polytropes in post-Newtonian approximation to general, rapidly rotating, 25:58495
- singularities in general, trapped surfaces for development of, 25:59602
- singularity in general, 25:59595
- space--time in general, measurement method for Riemannian structure of, 25:59608
- space--time in general, observable effects of torsion in, 25:59605
- space--time torsion in rotating and accelerated reference frames in, group deformations for, 25:59531
- stability of stars undergoing phase change, (T), 25:58425
- test for general, decisive, (T), 25:58664
- theory for coordinate-free, 25:59588
- variational formulation of fluid thermodynamics in, (T), 25:58674
- variational principle in general, general formulation of tetrad, 25:59600

REMOTE-CONTROL EQUIPMENT
- development for fuel examination hot cells, 25:58344(R) (LA-4693)

REMOTE-HANDLING EQUIPMENT
- design characteristics of liquid sodium cooled fast reactor, 25:60087
- design for radioactive materials, 25:57719(P)
- design parameters of liquid sodium cooled fast test reactor, 25:60174
- development for fuel examination hot cells, 25:58344(R) (LA-4693)
- gripping device for, design parameters of, 25:60259(P)

REMOTE-VIEWING EQUIPMENT
- development for welded joints in reactors, 25:57680 (ORNL-TM-3561)

RESISTORS
- radiation effects on silicon carbide, gamma, (E), 25:57903

RETICULO-ENDOTHELIAL SYSTEM
- scintigraphy in man with hematological diseases, use of technetium-99m colloids for, 25:58053

RHEINSBERG POWER REACTOR
- personnel for, training school for, 25:59916

RHENIUM
- effects on electric properties of lanthanum boride, temperature dependence of, 25:59183
- effects on electric properties of lanthanum hexaboride, 25:59182
- effects on thermal cycling stability of molybdenum and tungsten, 25:58247
- radiation effects on electric conductivity of pure, at 5°K, annealing recovery of alpha-particle, 25:59142
- radiation effects on mechanical properties of mono- and polycrystals of, neutron, 25:58342
- radioinduced defects in, at absolute melting temperature, electron microscopic study of fast neutron, 25:58302
- reactions of recoil atoms of, in proton-irradiated potassium chlororhenate or sodium perrhenate, effects of thermal annealing on, 25:57497

RHENIUM ALLOYS AND SYSTEMS
- Re--W-base, compatibility with cobalt-59 fuels at 1200 to 1400°C, 25:57654(R) (DP-1279)
- Re--W-base, creep rupture of deformed powder metallurgy, at 500 psi, mechanisms of, 25:58213 (ORNL-TM-3350)

RHENIUM ISOTOPES
- production of short-lived radioactive, by proton bombardment of ammonium rhenate or osmium, 25:57480 (JINR-P6-5955)

RHENIUM ISOTOPES Re-186
- use of tracer for measuring steam quality in boiler tubes, 25:57674

RHODIUM
- separation from palladium and ruthenium by coprecipitation with ferric hydroxide, 25:57552

RHODIUM ALLOYS AND SYSTEMS
- Cm--Rh, preparation of intermetallic $CmRh_3$, by oxide reduction reactions, 25:57658(R) (ORNL-4723)
- Hf--Pt-base--Rh--Ti--W, hardness of crystallized, effects of annealing at high temperatures on, 25:57658(R) (ORNL-4723)
- Pt-base--Rh--W, compatibility with tungsten at high temperatures, 25:57658(R) (ORNL-4723)
- Pt-base--Rh--W, hardness of crystallized, effects of annealing at high temperature on, 25:57658(R) (ORNL-4723)

RIBOSE, DEOXY-
- radiolysis of aqueous solutions of, products from electron pulse, 25:57930

RING CURRENT
- location of magnetospheric, (T), 25:58854
- plasma instabilities in magnetospheric, review of, 25:58895

RIVERS
- sodium-22 content of USSR, effects of 1961 and 1962 atmospheric nuclear explosions on, 25:57568

ROBERT E. GINNA POWER REACTOR, UNIT 1
- coolant activity for, measurements for 1520 MW(t) operation, 25:59942 (DOCKET-50244-81)
- personnel for, retraining requirements for 1520 MW(t) operation, 25:59942 (DOCKET-50244-81)
- power level for, requested information for increase to 1520 MW(t), 25:59942 (DOCKET-50244-81)
- testing program for, description of 1520 MW(t) operation, 25:59942 (DOCKET-50244-81)

ROCKET MOTOR NOZZLES
- cooling by transpiration, effects on nozzle thermal load, 25:57640 (N-71-22591)

ROCKET REACTORS (NERVA)
- testing of NRX-A6, off-site radiological monitoring for, 25:60195 (SWRHL-78-r)

ROCKS
- analysis for ultramicroamounts of thorium by photometry, 25:57342
- analysis of standard, for selenium by neutron activation, 25:57380
- uranium desorption and recrystallization in, during metamorphism, 25:57581

RODS
- vibration of slender single and bundles of, within fluid-filled tube, study of acoustically-induced, (E/T), 25:57621 (TRG-Report-2141)

ROVER REACTORS
- fuel elements for, masked probe for eddy current inspection for coating cracks in, 25:57699
- fuels for, burn-leach process for reprocessing of, 25:57519 (IN-1484)
- testing of Pewee 1, off-site radiological monitoring during, 25:60196 (SWRHL-87-r)

RUBBER
- reactions of sponge, with fluorine, 25:57619 (RFP-1739)

RUBIDIUM
- electromigration in molten chlorides, 25:57439
- separation from MSBR fuel solvent by reductive extraction, 25:57298 (ORNL-4676, pp 73-138)

RUBIDIUM BROMIDES
- Li--LiBr--RbBr--Se, thermodynamic properties of, emf measurements of, 25:58387(R) (ANL-7823)

RUBIDIUM CHLORIDES
- radiation effects on electric conductivity of crystals of, effects of divalent cation impurities on 1.2-MeV-electron, 25:59172
- KCl--RbCl, radiation effects on electric conductivity of crystals of, effects of divalent cation impurities on 1.2-MeV-electron, 25:59172

RUBIDIUM FLUORIDES
- $RbBF_4$--RbF, phase diagram of, 25:57298 (ORNL-4676, pp 73-138)

RUBIDIUM FLUOROBORATES
- $RbBF_4$--RbF, phase diagram of, 25:57298 (ORNL-4676, pp 73-138)

RUBIDIUM ISOTOPES Rb-85
- neutron reactions (n,2n) at 14.8 MeV, cross sections and gamma spectra from, (E), 25:59797

RUBIDIUM ISOTOPES Rb-87
- neutron reactions (n,2n) at 14.8 MeV, cross sections and gamma spectra from, (E), 25:59797

RUBIDIUM THORIUM FLUORIDES
- crystal structure, 25:57298 (ORNL-4676, pp 73-138)

RUBIDIUM URANYL NITRATES
- symmetry types of uniaxial and biaxial crystals of, 25:58703

RUBIDIUM ZIRCONIUM FLUORIDES
- crystal structure, 25:57298 (ORNL-4676, pp 73-138)

RUTHENIUM
- analysis for oxygen by vacuum fusion method, 25:57329
- determination by spectrophotometry using 3,4-diaminobenzoic acid, 25:57325
- separation from fission products as gaseous ruthenium tetroxide by ferric oxide--silica filters, 25:57532
- separation from gases by ferric oxide--silica filters, 25:57532
- separation from palladium and rhodium by coprecipitation with ferric hydroxide, 25:57552
- separation of berkelium from, by sorption on zirconium phosphate--silicate, 25:57530

RUTHENIUM ALLOYS AND SYSTEMS
- Pu--Ru, thermodynamic properties of intermetallic $PuRu_2$, at 913 to 1078°K, measurement using emf cells, 25:58211 (LA-4758)

RUTHENIUM ISOTOPES Ru-106
- separation from copper extracted from nuclearly fractured ores, method for, 25:57523 (ORNL-4677)

S

S-MATRIX
- equations for coefficient functions of, Kirkwood--Saltzburg, 25:59622
- relation with second virial coefficient, new derivation of, 25:59220
- review on theory and use for particle physics, 25:59614
- singularities of, review on, 25:59613

SAFETY
- regulations regarding nuclear, in Hungary, 25:58027

XUM

SAINT LAURENT-DES-EAUX REACTOR (EDF-4)
  design characteristics of, 25:59896
  fuel element meltdown in, recovery operations following, 25:59924
  startup of, 25:59896
SALEM POWER REACTOR, UNIT 1
  construction of, request for not suspending permit for, 25:59957 (DOCKET-50272-20)
SALEM POWER REACTOR, UNIT 2
  construction of, request for not suspending permit for, 25:59957 (DOCKET-50272-20)
SALIVA
  radiation effects on electrophoretic pattern of proteins in human, 25:57945
SAMARIUM
  abundance on surfaces of peculiar A stars, (E/T), 25:58462
  complexes with HEDTA, dissociation constants for, 25:57537
  determination in cobalt alloys, spectrographic, 25:57313
  determination in fluorite by solvent extraction and spectrography or fluorimetry, 25:57332
  determination in silicate rocks by neutron activation, low-energy photon detector for, 25:57387
  optical properties at 1.13 to 3.96 eV, 25:59187
  oxidation potential for trivalent--tetravalent, 25:57437
  separation from europium and neodymium in chloride solution by solvent extraction using DEHPA in heptane, factors for, 25:57543
SAMARIUM ALLOYS AND SYSTEMS
  Gd--Sm, magnetic properties at 77 to 1100°K, 25:59176
SAMARIUM IONS
  energy level interactions in Sm II, 4f--5d, (T), 25:58697
SAMARIUM ISOTOPES
  energy level transitions of, structural corrections in pair conversion coefficients in M1, (T), 25:59861
SAMARIUM ISOTOPES Sm-142
  beta and electron-capture decay of, β, γ, and conversion electron spectra from, (E), 25:59821
SAMARIUM ISOTOPES Sm-145
  electron-capture decay of, gamma and x-ray spectra, log-ft values, and relative K-capture probability for, (E), 25:59799
SAMARIUM ISOTOPES Sm-152
  alpha inelastic scattering at 10 to 12 MeV with Coulomb excitation, cross sections for, (E), 25:59823
  energy-level transitions from Coulomb excitation, moments for E4, (E), 25:59823
  nuclear deformation from Coulomb excitation, (E), 25:59823
SAMARIUM ISOTOPES Sm-154
  alpha inelastic scattering at 10 to 12 MeV with Coulomb excitation, cross sections for, (E), 25:59823
  energy-level transitions from Coulomb excitation, moments for E4, (E), 25:59823
  nuclear deformation from Coulomb excitation, (E), 25:59823
  preparation of monocrystalline, by grain growth annealing, 25:58184 (CONF-711002-, pp 181-90)
SAMARIUM OXIDES
  reduction to metal using thorium with simultaneous distillation separation, 25:58184 (CONF-711002-, pp 181-90)
SAMPLING
  methods for airborne radioactive materials, in nuclear facilities, standard for, 25:57712
SAN ONOFRE POWER REACTOR, UNIT 1
  control elements for, revised insertion limits for Cycle 3 operation of, 25:59940 (DOCKET-50206-127)
  core burnup limit for, request for increase to 18000 MWD/MTM for Cycle 2, 25:59939 (DOCKET-50206-126)
SATELLITES
  radiation detection equipment on TD-1, HEOS-B, and COS-B, (E), 25:58829
SATURN (PLANET)
  interior of, phase diagrams of hydrogen and helium in, (E), 25:58675
SAXTON POWER REACTOR
  coolant purification system for, increase in hydrogen pressure ratings for primary, 25:59937 (DOCKET-50146-94)
  coolant purification system for, increase in hydrogen pressure ratings for primary, 25:59936 (DOCKET-50146-93)
SCALERS
  design and construction of four-decade digital log, 25:57893
SCANDIUM
  effects on periodic precipitation in silver--cadmium alloys, 25:58262
  effects on spectrophotometric determination of yttrium, 25:57318
  separation from thorium by ion exchange, 25:57342
  spectra and energy levels of I and II, analysis of arc and spark, 25:58701
SCANDIUM ALLOYS AND SYSTEMS
  O--Sc--V, phase studies at 1000 to 1500°C, 25:58401
SCANDIUM ISOTOPES Sc-46
  content in Columbia River sediments, (E), 25:57561 (TID-25786)
SCANDIUM ISOTOPES Sc-48
  energy levels from calcium-48 (p,nγ) reactions, spin-parity assignments for, (E), 25:59756
  energy-level transitions from calcium-48 (p,nγ) reactions, internal conversion coefficients for, (E), 25:59756
SCANDIUM ISOTOPES Sc-49
  energy levels from calcium-48 (p,γ) reactions, symmetry energy for collective electric dipole, (E), 25:59742
SCANDIUM SELENIDES
  dissociation energy of, 25:57435(R) (COO-1029-39)
SCATTERING
  amplitude for three-particle, 25:59616
  amplitude of, new derivation of second virial coefficient with two-body, 25:59220
  amplitudes at high energies, selection rules for Regge cuts in, 25:59440
  amplitudes at high energy, generalized eikonal approximation and impact phase averaging for, 25:59610
  amplitudes in dual resonance models, zeros of multiparticle, 25:59625
  amplitudes in multi-Regge model, factorization into signature terms of, 25:59611
  amplitudes in Neveu--Schwarz model, dual one-loop, 25:59433
  amplitudes of elastic, in nonlocalizable field theories, bounds on, 25:59565
  amplitudes of high-energy, scaling behavior and Regge behavior from light-cone singularities of, 25:59617
  amplitudes of quasi-elastic, negative-energy timelike states from analytic continuation of, 25:59609 (KFKI-71-39)
  amplitudes of zero-spin equal-mass-particle elastic, upper bound on absorptive part of, 25:59630
  amplitudes of, crossing symmetry of partial waves, tests of crossing-symmetric models, and multivariable expansion of, 25:59619
  amplitudes of, extrapolation off boundary of analytic region of, 25:59621
  amplitudes of, finite- and infinite-dimensional local irreducible representations of O(3) symmetry for construction of, 25:59536
  amplitudes of, group theory for structure of generalized Veneziano, 25:59628
  amplitudes of, Radon transforms for structure of generalized Veneziano, 25:59627
  book: Scattering, Reactions, and Disintegrations in Nonrelativistic Mechanics (in Russian), 25:59612
  cross sections from beam experiments on, velocity correction factors for, 25:58757
  eikonal approximation for Mandelstam diagram with Regge pole and single-particle exchange, 25:59629
  Lippmann--Schwinger equation for, existence of solutions of two-particle, 25:59626
  matrix elements for, estimate of turning-point error in JWKB, 25:58737
  partial-wave model for, uniformized soluble, 25:59620
  potential for nonrelativistic L-wave inverse, Schroedinger equation for, 25:59623
  potential, differential equation for off-shell two-particle T-matrix for Hulthen, 25:59631
  potential, existence of solutions of two-particle Lippmann--Schwinger equation for, 25:59626
  Regge pole theory for short-wavelength, 25:59615
  S-matrix theory for, 25:59614
  theory of high-energy atomic and nuclear, review, 25:58775
  three-body problem in, three-dimensional covariant formulation of quantum field theory for, 25:59577
  wave function for free-incident-particle three-body, asymptotic form of, 25:59624
SCHIZOMYCOTA
  Actinomyces hygroscopicus, radioinduced mutations in spores of, effects of hygromycin B and streptomycin on frequency of x, 25:57964
  Azotobacter chroococcum, radiation effects on survival of, effects of cell age and content on γ, 25:58156
  Escherichia coli, radiation effects on DNA of, enzymatic repair of uv, 25:57928
  Escherichia coli, radiation effects on F-prime sex factors in, induction of prophage lambda through conjugal transfer of uv, 25:57956
  Escherichia coli, radiation effects on survival of, sensitizing effects of colloidal selenium and selenourea on x, 25:58155
  Escherichia coli, radiation effects on, protective effects of ethylene glycol against γ, 25:58157
  Escherichia coli, radioinduced mutations in, effects of 5-bromouracil substitution of DNA on frequency of uv, 25:57965
  Micrococcus luteus, radiation effects on DNA of, role of nucleases in repair of uv, 25:57935
  Micrococcus luteus, radiation effects on release of nucleotides from DNA of, uv, 25:57928
  Nitrobacter agilis, nitrification in soil suspension, effects of elements on, 25:57401
  radioinduced chromosome aberrations in, role of DNA repair in recovery of, 25:57970
  Thiobacillus ferrooxidans, effects on oxidation of iron and sulfide minerals in uranium deposits, method for enhancing, 25:57582
  Vibrio sp., disease production by, species and

XUM

  temperature dependence of, 25:60283(R) (RLO-2225-T-10-3)

SCINTILLATION CAMERAS
  performance of double-detector, for visualization of cold nodules in bulky organs, 25:57763

SCREENS
  performance of metal intensifying, for radiography, 25:57690

SEALS AND GLANDS
  design characteristics for rotatable cover, for liquid metal cooled reactor core vessels, 25:60021(P)

SEAS
  radioactive waste disposal into, IAEA panel recommendations on, 25:57708

SEAWATER
  analysis for cesium by precipitation using AMP and emission photometry, 25:57301 (TID-25776)
  analysis for cesium-134 and cesium-137 by precipitation using AMP and γ counting, 25:57348 (TID-25777)
  analysis for cesium-137 by radiochemical isolation and γ spectrometry or beta detection, 25:57355
  analysis for strontium by atomic absorption spectrophotometry, 25:57310
  radioisotope chemical states in, effects of iron on, 25:57410
  separation of uranium from, by adsorption using titanic acid, 25:57337
  uranium distribution between calcareous skeletons and, 25:57409

SEDIMENTARY DEPOSITS
  seismic wave propagation through, near Project Dribble site in Mississippi, effects of stratigraphy on, 25:57596 (USGS-474-129)
  sonic velocity of, near Project Dribble site in Mississippi, (E), 25:57595 (USGS-474-112)
  uranium occurrence in permeable, 25:57584

SEISMIC WAVES
  discrimination between earthquake- and underground nuclear explosion-generated, using short period seismic array data, 25:57600
  effects of earthquake-generated, on nuclear power plants, models for simulating dynamic, (T), 25:57598
  generation and propagation by Cannikin Event at Amchitka Island, Alaska, studies of potential effects of, 25:57590 (COO-2138-4)
  generation and propagation of P, R, and S, from underground nuclear explosions, 25:57593 (TID-25572)
  ground motion from, method for calculating linear dynamic response of buildings to, 25:57592 (JAB-99-70)
  propagation through rocks near Project Dribble site, velocity cross section data for interpreting, 25:57595 (USGS-474-112)
  propagation through sedimentary rocks at Project Dribble site, effects of stratigraphy on, 25:57596 (USGS-474-129)
  spectra of P, generated by earthquakes and underground nuclear explosions, method for seismic event identification using, 25:57599

SEISMOLOGY
  research in India, development of, 25:57591 (INIS-mf-71, pp 181-98)
  review on underground nuclear explosion, 25:57593 (TID-25572)

SELENIUM
  determination in glacial ice, by neutron activation and radiochemical separation, 25:57394
  determination of trace amounts of, by neutron activation, 25:57380
  determination of trace amounts of, in tellurium by photometry, 25:57323
  determination simultaneously with gold and tellurium in water by neutron activation, 25:57370
  radioinduced production in germanium, effects on infrared absorption, 25:58343
  radiosensitizing effects of colloidal, on anoxic bacteria, x, 25:58155

SELENIUM ISOTOPES Se-75
  effectiveness for scintigraphy of liver and thyroid gland, 25:58054
  energy level at 287 keV, lifetime for, (E), 25:59771
  evaluation for scanning human mammary glands for localization of neoplasms, 25:58051
  evaluation of selenomethionine-labeled, for scintigraphy of pancreas, 25:58061
  use of methionine-incorporated, for scintigraphy of pancreas with colloidal gold-198 liver subtraction by means of television reproduction, 25:58059

SELENIUM ISOTOPES Se-76
  energy levels from arsenic-76 beta decay, spin--parity assignments for, (E), 25:59748

SELENIUM ISOTOPES Se-80
  energy levels from arsenic-80 beta decay, spin--parity assignments for, (E), 25:59749

SELENIUM ISOTOPES Se-82
  neutron reactions (n,2n) at 14.7 MeV, isomer ratio in, (E), 25:59766

SELENIUM SYSTEMS
  Li--LiBr--RbBr--Se, thermodynamic properties of, emf measurements of, 25:58387(R) (ANL-7823)

SEMICONDUCTORS
  defects in irradiated, review of theory of, 25:59131
  ion implantation doping of, using electromagnetic isotope separators, 25:57650 (CONF-711002-, pp 10-20)
  ion implantation in binary III--V, review, 25:59168
  radiation effects on properties of, review of ion, 25:59173
  radiation effects on silicon carbide, gamma, (E), 25:57903

SEQUOYAH POWER REACTOR, UNIT 1
  construction of, request for not suspending permit for, 25:59977 (DOCKET-50327-20)

SEQUOYAH POWER REACTOR, UNIT 2
  construction of, request for not suspending permit for, 25:59977 (DOCKET-50327-20)

SERINE
  radiation effects on metabolism in pea and wheat plants and their offspring, gamma, 25:57931

SEWAGE
  radiosterilization of, design of spiral-flow gamma facility for, 25:57636(P)

SEYFERT GALAXIES
  model for NGC 5548, (E), 25:58655
  radiations from nuclei of, (T), 25:58629
  radio emission from core sources in, at 1415 MHz, (E), 25:58642
  spectra of NGC 5548, Hα profile in, (E), 25:58655

SF MATERIALS ACCOUNTING
  records for, standards for compiling and maintaining, 25:57716

SHIELDED CONTAINERS
  design for shipping irradiated fast reactor fuel elements, engineering drawings for, 25:57720
  design for shipping of SPERT III irradiated fuels, 25:57703 (DPSPU-71-124-4A)
  design modification of ATMX-500 railroad car, for shipping radioactive materials, 25:57705 (MLM-1812)
  thermal cooling of high-level radioactive waste, before removal of loaded cylinders, method for, 25:57706 (ORNL-TM-3545)

SHIELDING
  gamma dose rate calculations for two-layered slab, using Monte Carlo method, (T), 25:59108
  gamma dose rate in two-layered slabs, semi-empirical representations of, 25:59117
  neutron dose rate in two-layered slabs, semi-empirical representations of, 25:59117
  radioprotective effects of tibial, in adult, neonatal, and weanling mice, comparison of x, 25:58110
  requirements for astronauts exposed to solar flares during duty on space stations, 25:58025(T) (ORNL-tr-2490)
  temperature distribution in concrete, for power reactors, 25:60056

SHIPPING
  container for irradiated fast reactor fuel element, design of shielded, 25:57720
  equipment for air-ride, of Mark II Test Assembly, vibration testing of, 25:57612 (HEDL-TME-71-114)
  regulations for hazardous materials, US Dept. of Transportation, 25:57710
  standard for safe, of radioactive materials through UK ports, 25:57711
  standards for British railway, of dangerous materials, 25:57713

SHIPS
  air conditioning for nuclear powered, effectiveness for filtering airborne radioactivity of, 25:60205
  development of nuclear powered, data summary on, 25:60207

SHOCK WAVES
  book: Protection of Animals Against Injury by Nuclear Weapons, 25:58026
  effects on sheep in two-man foxholes at various distances from 500-ton TNT charge, 25:60272 (DASA-2711)
  production in air and ground from above-ground and underground explosions, finite difference method for calculation of, 25:57594 (UCRL-73369)
  production of turbulent electrostatic, from laminar shocks, (E), 25:59020
  simulation of high-Mach-number magnetosonic, in plasma, (T), 25:59044
  stability of compression, in MHD flows in channels, 25:58848
  use for pre-ionization of theta-pinch plasmas, 25:59056

SILICATE ROCKS
  analysis by neutron activation, low-energy photon detector for, 25:57387

SILICIC ACIDS
  reactions with ferric and uranyl ions in aqueous solutions, spectrophotometric study of, 25:57406

SILICON
  analysis of semiconductor-grade silicon by proton activation, 25:57396
  determination in tellurium after extraction with TBP, spectrophotometric, 25:57324
  determination of trace amounts of, in uranium dioxide by spectrophotometry using molybdenum blue method, 25:57340
  effects on niobium nitride solubility in iron austenite, 25:58268
  electron reactions at 7 to 10 MeV, bremsstrahlung spectra from, (E), 25:59149

  ion implantations of lithium, boron, and phosphorus in, for use as charged-particle detectors, 25:57749
  ion ranges and stragglings in, calculations of 20- to 400-keV heavy, 25:59116
  neutron elastic and inelastic scattering at 7.71 to 9.05 MeV by natural, cross sections for, (E/T), 25:59770
  proton reactions at 6 to 52 MeV with natural, cross sections for aluminum-26 and sodium-22 formation in, (E), 25:59753
  radiation damage regions in, crystallinity of fission-neutron and ion-, (E/T), 25:59140
  radiation effects on electric conductivity of n- and p-type, subthreshold electron, 25:59127
  radioinduced defects in n- and p-type, review of electron and neutron, 25:59135
  radioinduced disorder in p-type, Rutherford-backscattering study of helium-ion, 25:59136
  reactions of recoil atoms of, research progress on, 25:57487(R) (COO-1713-25)
SILICON CARBIDES
  ion implantations in alpha-, disorder and location of 40-keV antimony and 30-keV nitrogen, 25:59171
  properties of whiskers of, for composite reinforcing materials, 25:58361
  radiation effects on cathodoluminescence spectrum of beta-, 3.5-MeV electron, (E/T), 25:59139
  radiation effects on ESR and optical transmission spectra of monocrystals of α-, α and neutron, 25:59154
  radiation effects on semiconductors of, gamma, (E), 25:57903
  Al--SiC, properties of carbide whisker reinforced composites of, 25:58361
SILICON IONS
  x-ray spectra of solar, (E), 25:58583
SILICON ISOTOPES Si-27
  energy level at 780 keV, lifetime for, (E), 25:59771
  energy levels from silicon-28 (He-3,$\alpha\gamma$) and magnesium-24 (α,nγ) reactions, lifetimes and spin--parity assignments for, (E), 25:59751
  energy-level transitions from silicon-28 (He-3,$\alpha\gamma$) and magnesium-24 (α,nγ) reactions, branching ratios for, (E), 25:59751
SILICON ISOTOPES Si-28
  energy levels from electron inelastic scattering, model analysis of, (E/T), 25:59736
  energy levels of, calculation for α-hole, 25:59757
  helium-3 reactions (He-3,$\alpha\gamma$) at 8.2 MeV, spectra from, (E), 25:59751
  photon reactions (γ,n) up to 35 MeV endpoint energy, excitation functions for, (E), 25:59772
  production in stars from simple helium burning, (E), 25:58508
SILICON ISOTOPES Si-29
  proton reactions (p,γ) at 900 to 2120 keV, γ spectra from, (E), 25:59760
SILICON ISOTOPES Si-32
  production in stars from simple helium burning, (E), 25:58508
SILICON JUNCTIONS
  rectifying process in, review of, 25:57741
SILICON OXIDES
  analysis of high-purity, for uranium by luminescence method, 25:57328
  coating with silver films induced by electron bombardment, mechanisms of selective, 25:58178 (AWRE-O-42/71)
  effects on thermostability of irradiated polyethylene, 25:57446
  preparation of thin-film targets of, using Zapon temporary backing, 25:59639 (CONF-711002-, pp 134-43)
  radioinduced intrinsic and impurity defects in, ESR study of, 25:59174
  reactions with zinc oxide to form zinc orthosilicate, ESR study of defect kinetics in, 25:59174
  CaO--Nb$_2$O$_5$--SiO$_2$--TiO$_2$, liquidus of pseudo-ternary CaO.Nb$_2$O$_5$--CaO.TiO$_2$--SiO$_2$ plane of, 25:58390
  polyethylene--SiO$_2$, radiation effects on mechanical properties and creep resistance of composites of, gamma, 25:58416(R) (RLO-2098-2)
SILICON SYSTEMS
  Al--Cu-base--Si, oxidation at high temperatures, mechanisms of, 25:58171
  C--Cr--Fe--Hf--Mn--Mo--Nb--Ni-base--Si--Ti--Zr, radiation effects on mechanical properties of, relations of composition with thermal neutron, 25:58168 (ORNL-4676, pp 139-233)
  C--Cr--Fe--Ni--Si--W, metallography of carbide structures in cast heat-resistant, 25:58399
  Cr--Ni-base/Ni-base--Si, development of thermocouple of, 25:57876
  Cu--Si, welding to steel, deposition of intermediate layers for, 25:58204
  Cu-base--Si, oxidation at high temperatures, mechanisms of, 25:58171
  Ge--Si-base, radioinduced disorder in p-type, Rutherford-backscattering study of helium-ion, 25:59136
SILTS
  analysis for mercury by neutron activation and radiochemical separation, 25:57392
  characteristics of Columbia River, effects on radioisotope content in river water of chemical, mineral, and physical, (E), 25:57561 (TID-25786)
  radiation monitoring of seabed, equipment and method for in-situ gamma, 25:57586
  radioactivity in Mt. Obora, Japan, measurements of, 25:57566
  radioisotope content of Columbia River, (E), 25:57561 (TID-25786)
  thorium-230 abundance variations in ocean-bottom, 25:57588
  thorium-230/uranium-234 ratio in iron-rich East Pacific Rise, 25:57585
  uranium abundance variations in ocean-bottom, 25:57588
  uranium-234/-238 ratio in iron-rich East Pacific Rise, 25:57585
SILVER
  deposition on silicon dioxide by electron bombardment, comparison with silicon monoxide reactions, 25:58178 (AWRE-O-42/71)
  determination by extraction using quinolinol melt and spectrography, 25:57312
  effects on oxidation of hexavalent neptunium by potassium persulfate, 25:57412
  helium-ion reactions at 45 to 90 keV/amu with, helium-isotope dependence of cross sections for L-shell ionization in, (E), 25:58776
  ionization cross sections of, measurement of, 25:58344(R) (LA-4693)
  meson (π^-) inelastic scattering at 3.5 GeV/c with charged-particle evaporation, charged-particle energy spectra and angular distributions for, (E), 25:59822
  preparation of radiation targets of, by argon ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
  preparation of thin-film targets of, using Zapon temporary backing, 25:59639 (CONF-711002-, pp 134-43)
  proton reactions (p,γ) at 4 MeV with natural, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801
  proton stopping power at 20 to 1000 keV of, electronic, (T), 25:59124
  radioinduced helium production in foils of, fast neutron, 25:58334
SILVER ALLOYS AND SYSTEMS
  preparation of reference specimens of, methods for, 25:58179 (CONF-711002-, pp 47-58)
  Ag--Al--In, phase studies at 143 to 506°C, isothermal, 25:58287
  Ag--Au-base, radioinduced crowdions in, comments on evidence for electron, 25:59162
  Ag--Au-base, radioinduced crowdions in, stabilization of electron, (T), 25:59153
  Ag-base--Cd, precipitation in, effects of aluminum, beryllium, magnesium, scandium, and yttrium additions on periodic, 25:58262
  Ag-base--Cu--In, bonding to lead telluride, methods for solid-state, 25:58207
SILVER CHLORIDES
  AgCl--NaCl, effects on direct spectrographic determination of trace amounts of metals in zirconium dioxide, 25:57335
SILVER ISOTOPES Ag-110
  use of metastable, as tracer for determining current efficiency in aluminum oxide electrolysis, 25:58360
SINGLE CRYSTALS
  charged-particle scattering by, quantum/classical transition in, (T), 25:59157
  dislocation damping forces in, 25:60264 (CALT-767-P-3-15)
  particle energy loss distribution in, effects of channeling on heavy positive, (T), 25:59150
SINTERING
  method for activated, of metals and ceramics, 25:58200
SKIN
  barium-140 distribution in tissues of, following cutaneous application, 25:57917
  decontamination of human, effectiveness of acetic acid derivatives for, 25:57982
  epidermis thickness of human, in relation to age, body site, and sex, 25:58000 (RD/B/R-1934)
  radiation effects on cell division in epidermis of human, from mammary tumors, x, 25:58146
  radiation effects on human, methods for treatment of ulcerogenic x, 25:58038
  radiation effects on iodine-131 clearance rate in human and rabbit, x, 25:58125
  radioinduced ulceration in rabbit, protective effects of desoxycorticosterone acetate, methionine, and vitamin A against x, 25:58036
  strontium-89 distribution in tissues of, following cutaneous application, 25:57917
SLURRIES
  x-ray scattering from, effects of particle size on Compton and Rayleigh, 25:59118
SODIUM
  analysis for impurity carbon, hydrogen, and oxygen, development of on-line meters for, 25:60058(R) (ANL-7817)
  analysis for iodine-135, development of method for, 25:60058(R) (ANL-7817)
  analysis for iron, spark mass spectrometric, 25:58163(R) (AI-AEC-12859)
  analysis for oxygen, development of in-line meter for, 25:58163(R) (AI-AEC-12859)

analysis for particulate impurities, development of methods for, 25:60058(R) (ANL-7817)
analysis of loop, for carbon and oxygen, 25:58166(R) (AI-AEC-12980)
boiling in liquid metal cooled fast reactors, effects of fuel element failures and coolant flow blockage on, 25:60117 (KFK-1380)
boiling in liquid, development of high temperature sonic detectors for, 25:60090
boiling in liquid, development of methods for detection of, 25:60089
boiling of liquid, analysis of stable and transient flow characteristics during, 25:60112 (CEA-CONF-1797)
carbon distribution between steels and liquid, equilibrium, (E), 25:60058(R) (ANL-7817)
corrosive efects of flowing high-temperature, on Types 304 and 316 stainless steel, 25:58163(R) (AI-AEC-12859)
corrosive effects of flowing, on Type 316 stainless steel, 25:58167(R) (AI-AEC-12987)
corrosive effects of liquid, on fast breeder reactor materials, (E/T), 25:60010(T) (EURFNR-902)
corrosive effects of Types 304 and 316 stainless steel at high temperature, metallographic studies of, 25:58174
corrosive effects on stainless steel loops, 25:58170 (RD/B/N-1998)
determination in analytical reagents by neutron activation, 25:57379
determination in irradiated mixed oxide fuels, spectrochemical, 25:58344(R) (LA-4693)
determination in Roanoke River water by neutron activation and γ spectrometry, 25:57395
determination in solid rocket propellants by neutron activation and gamma spectroscopy, 25:57384
determination of extracellular, in man, radioisotope dilution method for, 25:57924
effects in combination with helium on stress rupture of Types 304 and 316 stainless steel at 900 to 1200°F, 25:58167(R) (AI-AEC-12987)
effects of dynamic and static high-temperature, on mechanical properties of Types 304 and 316 stainless steel, 25:58167(R) (AI-AEC-12987)
effects of dynamic and static high-temperature, on mechanical properties of Types 304 and 316 stainless steel, 25:58166(R) (AI-AEC-12980)
effects of high-temperature, on mechanical properties of Type 304 and 316 stainless steel, 25:58163(R) (AI-AEC-12859)
effects on complexonometric determination of rare earths, 25:57317
electromigration in molten chlorides, 25:57439
flowmeters for liquid, development of eddy current probe, 25:60184
flowmeters for liquid, development of permanent magnet probe, 25:60183
flowmeters for liquid, performance of magnet flow-through, 25:60182
hydrogen content in liquid, development of diffusion tube detector for monitoring, 25:57877
impurities in coolants of, design of collector for, 25:57624(P)
purification for use in fundamental studies, methods for, 25:58163(R) (AI-AEC-12859)
purity specifications for liquid, for large operating reactor loops, 25:60058(R) (ANL-7817)
reactions with deuterium, hydrogen, and nitrogen molecules, excitation cross sections for, (E), 25:58778
reactions with nitrogen and sulfur dioxides at 1 to 30 eV, light emission and excitation cross sections for, (E), 25:58749
solvent properties for bismuth at high temperatures, 25:58163(R) (AI-AEC-12859)
solvent properties for carbon at high temperatures, 25:58163(R) (AI-AEC-12859)
solvent properties for chromium at high temperatures, 25:58163(R) (AI-AEC-12859)
solvent properties for irradiated iron, 25:58163(R) (AI-AEC-12859)
solvent properties for niobium at high temperatures, 25:58163(R) (AI-AEC-12859)
solvent properties for noble gases, 25:58387(R) (ANL-7823)
solvent properties for titanium at high temperatures, 25:58163(R) (AI-AEC-12859)
Na--NaH--NaOH--Na_2O, phase diagram of, 25:60058(R) (ANL-7817)

SODIUM ALUMINUM SILICATES
$NaAlSiO_4$--polyethylene, radiation effects on mechanical properties and creep resistance of composites of, gamma, 25:58416(R) (RLO-2098-2)

SODIUM AMIDES
spectra at 220°C, Raman, 25:58387(R) (ANL-7823)
vibration spectra of, pulsed neutron-scattering of, 25:58384

SODIUM BROMIDES
radiolysis of frozen aqueous solutions of, ESR study of hydrogen atoms and hydroxyl radicals from, 25:57467

SODIUM CHLORIDES
copper (II) ion ESR spectra in, 25:59201
nickel (I) ion ESR spectra in, 25:59201
radiation effects on valence distribution of ion-implanted sulfur-35 in crystals of, γ, 25:57503
radioinduced F centers in crystals of, effects of prior electric field treatment on kinetic stages of γ-, (E/T), 25:59164
radioinduced F color centers in, thermal aggregation of x, 25:59152
radiolysis of frozen aqueous solutions of, ESR study of hydrogen atoms and hydroxyl radicals from, 25:57467
sulfur-35 valence distribution after ion implantation in, effects of pre-bombardment with chlorine, sulfur, and oxygen on, 25:57503
AgCl--NaCl, effects on direct spectrographic determination of trace amounts of metals in zirconium dioxide, 25:57335

SODIUM FLUORIDES
analysis of molten, for hydrogen- and deuterium-containing impurities, spectroscopic, 25:57298 (ORNL-4676, pp 73-138)
copper (II) in ESR spectra in, 25:59201
radiolysis of frozen aqueous solutions of, ESR study of hydrogen atoms and hydroxyl radicals from, 25:57467
BeF_2--NaF, electric conductivity of molten and supercooled, 25:57298 (ORNL-4676, pp 73-138)
BeF_2--NaF, phase transitions in molten, 25:57298 (ORNL-4676, pp 73-138)
KI--NaF, effects on direct spectrographic determination of trace amounts of metals in tungsten trioxide, 25:57335
$NaBF_4$--NaF, corrosive effects of molten, on Inconel, 25:57298 (ORNL-4676, pp 73-138)
$NaBF_4$--NaF, corrosive effects on Hastelloy N and Haynes 25 alloys at 460 to 600°C, 25:58169 (ORNL-TM-3488)
$NaBF_4$--NaF, corrosive effects on Hastelloy N and Inconel 600 at high tempertures, 25:58168 (ORNL-4676, pp 139-233)
$NaBF_4$--NaF, reactions of molten, with water, 25:57298 (ORNL-4676, pp 73-138)

SODIUM FLUOROANTIMONATES
radiation effects on, ESR spectra of radicals from γ, 25:57445

SODIUM FLUOROBORATES
analysis of molten, for hydrogen- and deuterium-containing impurities, spectroscopic, 25:57298 (ORNL-4676, pp 73-138)
spectra of polycrystalline, Raman, 25:57298 (ORNL-4676, pp 73-138)
$NaBF_4$--NaF, corrosive effects of molten, on Inconel, 25:57298 (ORNL-4676, pp 73-138)
$NaBF_4$--NaF, corrosive effects on Hastelloy N and Haynes 25 alloys at 460 to 600°C, 25:58169 (ORNL-TM-3488)
$NaBF_4$--NaF, corrosive effects on Hastelloy N and Inconel 600 at high tempertures, 25:58168 (ORNL-4676, pp 139-233)
$NaBF_4$--NaF, reactions of molten, with water, 25:57298 (ORNL-4676, pp 73-138)

SODIUM HYDRIDES
Na--NaH--NaOH--Na_2O, phase diagram of, 25:60058(R) (ANL-7817)

SODIUM HYDROXIDES
solvent properties of aqueous, for cobalt, tungsten, and tungsten carbide, 25:58177
Na--NaH--NaOH--Na_2O, phase diagram of, 25:60058(R) (ANL-7817)
$NaNO_3$--NaOH, solvent properties of aqueous, for tungsten carbide, 25:58177

SODIUM HYPOCHLORITES
effects on radioinduced decoloration of textile dye solutions, 25:57452

SODIUM IODIDES
radiolysis of frozen aqueous solutions of, ESR study of hydrogen atoms and hydroxyl radicals from, 25:57467

SODIUM IONS
electron reactions with, model potentials for, 25:58772
reactions with neon and nitrogen molecules in keV range, production of K vacancies in, (E), 25:58756

SODIUM ISOTOPES Na-22
content in USSR rivers, effects of 1961 and 1962 atmospheric nuclear explosions on, 25:57568
content of cosmogenic, in inland surface waters, uses in hydrological studies, 25:57568

SODIUM ISOTOPES Na-23
photon reactions (γ,n) with, energy dependence of yield for, (E), 25:59815

SODIUM NITRATES
solvent properties of aqueous, for cobalt, tungsten, and tungsten carbide, 25:58177
$NaNO_3$--NaOH, solvent properties of aqueous, for tungsten carbide, 25:58177

SODIUM OXIDES
Na_2O--TeO_2, radiation effects on structure of glasses of, EPR studies on effects of metal oxide additives on γ, 25:57447
Na--NaH--NaOH--Na_2O, phase diagram of, 25:60058(R) (ANL-7817)

SODIUM PERRHENATES
radiation effects on crystals of, thermal annealing of recoil rhenium atoms from proton, 25:57497

SODIUM SALICYLATES
radiosensitizing effects on Escherichia coli, γ, 25:58157

SODIUM THIOSULFATES
  sorptive properties for iodine and methyl iodide in ice condenser reactor containment systems, (E), 25:60124
SODIUM URANATES
  preparation and thermochemical properties of pentavalent and hexavalent, 25:57405
SOILS
  analysis for trace amounts of elements by resonance neutron activation and γ spectrometry, 25:57375
  radioactivity of Indian, measurements of gamma, 25:57567
  radioisotope content of Indian, gamma spectrometric measurements of, 25:57567
  strontium-90 content of agricultural, in East Germany, effects of fallout from nuclear weapons tests on, 25:57986
SOLAR ACTIVE REGIONS
  electron densities in, (E), 25:58599
  spectra of, radio and ultraviolet, (E/T), 25:58580
SOLAR CELLS
  development for spacecraft electric power systems, review on, 25:57671
SOLAR CORONA
  acoustic waves in, propagation of a spectrum of, (T), 25:58579
  brightness of, apparent surface, (E/T), 25:58618
  calcium abundance in, (E), 25:58605
  current sheets in, magnetic model of three-dimensional flowing, (E/T), 25:58616
  electron densities in, (E), 25:58621
  electron density and temperature in, (E/T), 25:58580
  electron temperatures in, (E), 25:58621
  expansion phenomena in, large-scale energy-associated, (T), 25:58894
  flare production in, mechanism for, (T), 25:58573
  loops in, magnetic-field strengths in, (E), 25:58606
  loops in, monochromatic observations of, (E), 25:58606
  polarization of, (E/T), 25:58618
  prominence formation in radiatively cooled, (T), 25:58571
  spectra of, profiles of 5303- and 6374-A lines in, (E), 25:58572
  transition layer with chromosphere, model for, (E/T), 25:58580
  ultraviolet spectra during eclipse of Mar. 7, 1970, (E), 25:58617
SOLAR DISTURBANCES
  planetary effects on distribution of calcium flocculi, (E), 25:58611
  relation to soft x-ray emission, (E), 25:58600
SOLAR FLARES
  bremsstrahlung in Oct. 24, 1969, (E), 25:58609
  distribution of, longitudinal, (T), 25:58570 (N-71-14166)
  effect on ionospheric electron content enhancements and sudden frequency deviations, (E), 25:58901
  effects on radiation dose to astronauts during prolonged duty on space stations, protective effects of shielding against, 25:58025(T) (ORNL-tr-2490)
  electron density in Oct. 24, 1969, (E), 25:58609
  magnetic fields in Oct. 24, 1969, (E), 25:58609
  mass motions in spray-type, (E), 25:58608
  prediction of, from statistical sunspot data in 1966, (T), 25:58592
  production mechanism for, (T), 25:58573
  proton emission during, longitude effects on delay of, (E), 25:58612
  proton events during space missions, risk of, (E/T), 25:58853 (N-71-27792)
  radio polarizations associated with Oct. 24, 1970, (E), 25:58620
  synchrotron emission in Oct. 24, 1969, (E), 25:58609
SOLAR GRANULES
  intensity fluctuations and velocities in, power spectrum analysis of, (E), 25:58594
SOLAR PARTICLES
  emission from March 1970 event, observations over polar cap and in radiation belt, (E), 25:58892
  energy losses by, direct observations of, (E), 25:58590
SOLAR PROMINENCES
  electron density in loop-type, of Aug. 12, 1970, (E), 25:58607
  energy balance in cool quiescent, (E/T), 25:58603
  formation of, due to thermal instability of radiatively cooled corona, (T), 25:58571
  gas streaming in, east--west, (E), 25:58601
  helium abundance in, (E), 25:58602
  magnetic fields in cool quiescent, (E/T), 25:58603
  production mechanism for, (T), 25:58573
  spectra of quiescent, Hα and K-line, (E), 25:58601
  spectra of, helium lines in, (E), 25:58604
  temperatures in loop-type, of Aug. 12, 1970, (E), 25:58607
SOLAR RADIATION
  relation to sunspot number at 600 to 9400 MHz during high and moderate solar activity, slowly varying component of, (E/T), 25:58614
SOLAR RADIO BURSTS
  emission from flare of Oct. 24, 1969, (E), 25:58609
  Faraday rotation dispersion in Type III, (E), 25:58610
  polarization characteristics of Type III, distribution of, (E), 25:58610
  relation to flare spray of Mar. 12, 1969, (E), 25:58608
SOLAR SPICULES
  heating of chromosphere due to, (T), 25:58619
SOLAR SYSTEM
  amino acid formation in early, catalytic synthesis, (E/T), 25:58575
  amino acid formation in early, catalytic synthesis, (E/T), 25:58576
  magnetic field in interplanetary space, large-scale properties of, 25:58582
  planetary formation from charged bodies ejected from Sun, (T), 25:58591
  planetary formation in, floccule theory of, (T), 25:58586
SOLAR WIND
  convection of solar particles by, outward, (E), 25:58590
  deceleration of, shock-free, (T), 25:58615
  directional fluctuations of, short-term, (E), 25:58581
  effect on aerodynamic parameters of magnetosphere, (E/T), 25:58908
  effect on angular momentum loss of Sun, (E), 25:58581
  effects on interplanetary hydrogen cone, (T), 25:58578
  helium interaction with, helium$^+$ ion abundance from photoionization of interstellar, (E/T), 25:58855
  interaction with interstellar hydrogen, (T), 25:58615
  interaction with interstellar hydrogen, effect on interstellar magnetic-field location, (T), 25:58631
  ion temperatures in, Venera-3 measurements on, (E), 25:58613
  observational data on, review of, (E), 25:58585
  parameters of, relation to magnetic activity, magnetotail electron flux, and radiation zone parameters, (E/T), 25:58852(T) (LA-tr-71-69)
  plasma penetration to low altitudes through high-latitude cusp in magnetopause, (E/T), 25:58882
  proton density, temperature, and velocity in, relation with magnetospheric substorm occurrences and interplanetary magnetic-field parameters, (E), 25:58856
  theory of quiet, review of developments on, 25:58894
  velocity from Sun, effect of interstellar magnetic shock front on, (T), 25:58631
  velocity of, Venera-3 measurements on, (E), 25:58613
SOLAR X-RAY BURSTS
  correlation with sudden phase anomalies in very sudden enhancements in wave fields, (E), 25:58888
  emission from flare of Oct. 24, 1969, (E), 25:58609
SOLIDS
  atom reactions with surfaces of, review of Auger and resonance processes in, (E/T), 25:58692
  diffusion in, short-circuiting effects in, 25:58209 (AECL-3952)
  electron scattering by magnetic, cross-section formulas for polarized-, 25:58687
  ion energy losses at low energies in, calculation using screened Coulomb potential, 25:59124
  ion implantation in, channeling-effect technique for study of, 25:59167
  ion implantation in, review of range distributions in, 25:59166
  ion reactions with surfaces of, review of Auger and resonance processes in, (E/T), 25:58692
  Markov approach to density fluctuations due to transport and scattering, 25:59237
  Markov approach to density fluctuations due to transport and scattering, 25:59236
  phonon interactions in, (T), 25:59204
  radiation-defect accumulation in radioactive, time-dependent self-, (T), 25:59170
  radioinduced void formation in, in high-voltage electron microscope, (T), 25:58316
  radioinduced void formation in, relations with dose and temperature, 25:58312
  rare gas release during annealing of ion-bombarded, review of stages of, 25:58412
  sputtering of, review of angular and energy distributions and yields from, 25:58693
  void interaction with dislocation loops in, (T), 25:58315
SOUND
  effects on vibration of slender rods within fluid-filled tube, (E/T), 25:57621 (TRG-Report-2141)
  propagation in bounded plane geometry, 25:59679
  propagation in solar atmosphere, (T), 25:58579
SOUTH AMERICA
  fallout monitoring during 1970, 25:57981(R) (HASL-245(App.))
  radioactivity of surface atmosphere and precipitation sampled during March 1971, gross β, 25:57992
  radioisotope content of milk during March 1971, barium-140, cesium-137, iodine-131, strontium-89, and strontium-90, 25:57990
SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR
  control rods of, cladding temperatures for FRED, 25:60153 (DOCKET-50231-97)
  management of, revised responsibilities for, 25:60152 (DOCKET-50231-96)
  operations during May to July 1971, 25:60154 (DOCKET-50231-98)
  personnel for, revised responsibilities for, 25:60152 (DOCKET-50231-96)

XUM

  testing program for, technical specifications for Core 2 transient, 25:60155 (DOCKET-50231-99)

SOVIET UNION
  granites from Central Kazakhstan in, statistical analysis of uranium distribution in, 25:57583
  sodium-22 content of rivers in, effects of 1961 and 1962 atmospheric nuclear explosions on, 25:57568

SPACE
  light polarization in interstellar, (E), 25:58488
  magnetic fields in interplanetary, large-scale properties of, 25:58582
  plasma and magnetic field in interplanetary, interactions with magnetosphere, (E/T), 25:58886
  spin states of atoms and molecules in interstellar, (T), 25:58665

SPACE FLIGHT
  proton events during, risk of solar, (E/T), 25:58853 (N-71-27792)
  radiation dose to astronauts during USSR Soyuz-9, preflight calculations of, 25:58006

SPACE VEHICLES
  economics of reusable interorbital, 25:60198
  power systems for, development of electric, 25:57671
  structures for, properties of composite materials in, 25:58422

SPECTROMETERS
  fabrication and testing of boron-implanted silicon, 25:57809

SPECTROSCOPY
  group theory for atomic, symmetry principles in, 25:58788

SPERMATOCYTES
  radioinduced mutations in adult, embryonic, and newborn mouse, comparison of frequency of x, 25:57967

SPHENE
  analysis for tantalum by neutron activation and γ spectroscopy, 25:57371

SPINAL CORD
  radiation effects on rat, orthodromic responses following x, 25:58101

SPLEEN
  radiation effects on hematopoiesis in mouse, following transplantation of bone marrow, 25:58117
  radiation effects on weight of mouse, effects of dose fractionation on whole-body cobalt-60 γ and x, 25:58108
  scintigraphy of reticuloendothelial system function in patients with hematological diseases, use of metastable technetium-99 colloids for, 25:58053
  scintiscanning of human, effectiveness of γ irradiated chromium-51-labeled erythrocytes for, 25:58136

SPORES
  radioinduced mutations in Actinomyces hygroscopicus, effects of hygromycin B and streptomycin on frequency of x, 25:57964

SPUTTERING
  method for radiofrequency, of thin-film radiation sources, 25:57651 (CONF-711002-, pp 147-59)
  methods for refractory metal radiation targets using argon ions, 25:59637 (CONF-711002-, pp 109-15)
  products of, review of angular and energy distributions and yields of, 25:58693

STABLE ISOTOPES
  preparation of radiation targets of, methods for, 25:59635 (CONF-711002-, pp 91-100)

STAINLESS STEEL
  bonding to aluminum, method for diffusion, 25:58207
  carburization-decarburization processes in liquid sodium systems, kinetics of, (E), 25:60058(R) (ANL-7817)
  coating instrument parts of, with neptunium, plutonium, thorium, or uranium as oxides by electrolytic deposition, 25:57440
  corrosion of loops of, by high-temperature sodium, 25:58170 (RD/B/N-1998)
  corrosion of sensitized, effects of various environments on stress, (E), 25:59886 (WCAP-7735)
  corrosion of Type 304, by molten MSRE fuel salts, 25:58168 (ORNL-4676, pp 139-233)
  corrosion of Type 316, by flowing sodium at 1200°F, 25:58167(R) (AI-AEC-12987)
  corrosion of Types 304 and 316, by flowing high-temperature sodium, 25:58163(R) (AI-AEC-12859)
  crack initiation and growth in Type 304, effects of low-cycle fatigue on, (E), 25:60061(R) (GEAP-10207-24)
  drawing of Type 304, testing of lubricants for deep, 25:58195
  fabrication of fuel cladding of, for nuclear powered ships, 25:58194
  joining to high-strength materials by continuous seam diffusion bonding, 25:58201
  mechanical properties of Type 316, effects of carburization on, 25:58167(R) (AI-AEC-12987)
  mechanical properties of Types 304 and 316, effects of dynamic and static high-temperature sodium on, 25:58166(R) (AI-AEC-12980)
  mechanical properties of Types 304 and 316, effects of dynamic and static high-temperature sodium on, 25:58167(R) (AI-AEC-12987)
  mechanical properties of Types 304 and 316, effects of high-temperature helium and sodium on, 25:58163(R) (AI-AEC-12859)
  metallography of Types 304 and 316, exposed to sodium at high temperature, 25:58174
  properties of austenitic, effects in design rules of FFTF structural elements of data in, 25:60115 (HEDL-SA-164)
  properties of Type 304L, for use in encapsulating californium-252, 25:58242
  radiation effects on biaxial stress rupture of Type 316, at 1000 to 1400°F, pile neutron, 25:58297 (HEDL-TME-71-72)
  radiation effects on density of Types M316, M316L, FV548, and EN58B, relations of void formation with fast neutron, 25:58306
  radiation effects on mechanical properties of welds on Type 304, relations of filler metal composition and weld process with fast neutron, 25:58296 (HEDL-SA-196)
  radiation effects on stress rupture of Types 304 and 316, alpha particle, 25:58163(R) (AI-AEC-12859)
  radioinduced atom displacement rates in, calculation of copper-ion and fast-neutron, 25:59144
  radioinduced helium production in, measurement of in-pile, 25:58163(R) (AI-AEC-12859)
  radioinduced swelling of helium-containing Type 316, relations of cold work on 20-MeV carbon ion, 25:58324
  radioinduced swelling of helium-containing Type 316, relations of temperature with proton, 25:58167(R) (AI-AEC-12987)
  radioinduced void formation in Type 316, effects of flux and temperature on proton, 25:58166(R) (AI-AEC-12980)
  radioinduced void formation in Types M316, M316L, and FV548, electron microscopic study of annealing of, 25:58307
  radioinduced void formation in, relations of helium content on 1-MeV electron, 25:58329
  radioinduced void swelling in helium-containing Type 316, relations of temperature with 20-MeV carbon ion, 25:58321
  radioinduced void swelling in helium-containing Type 316, relations of dose with 20-MeV carbon ion, 25:58322
  radioinduced void swelling in helium-containing Type 18/8/Ti, relations of temperature with 20-MeV carbon ion, 25:58323
  stress rupture of Type 306, effects of carburization on, 25:58166(R) (AI-AEC-12980)
  stress rupture of Types 304 and 316, combined effects of helium and sodium at 900 to 1200°F on, 25:58167(R) (AI-AEC-12987)
  tensile properties of Types 19-9DL and Sandvik 12R72, 25:58163(R) (AI-AEC-12859)
  epoxy resin--stainless steel, radiation effects on strength of joints of, gamma, 25:58416(R) (RLO-2098-2)

STANDARDS
  code of practice for shipping of radioactive materials through UK ports, 25:57711
  development of fast test reactor control system and instrumentation, 25:60180
  dosimeters, design of personnel ionization, BS 3385, 25:57830
  gamma sources for radiography, fabrication of, BS 3513, 1962, 25:57665
  gamma sources for radiography, shielding for, BS 4097, 1966, 25:57664
  guide for administrative practices in radiation monitoring, USAS N13.2 1969, 25:57714
  guide to practice nuclear material control systems for conversion facilities, ANSI N15.4-70, 25:57717
  hazardous materials regulations of the Dept. of Transportation including specification for shipping containers, Tariff No. 23, 1969, 25:57710
  method for controlling quality of radiographic testing, ASTM E142-68, 25:57682
  method for ultrasonic contact inspection of weldments, ASTM E164-65, 25:57685
  method for ultrasonic inspection of metal pipe and tubing for longitudinal discontinuities, ASTM E213-68, 25:57686
  methods for sampling airborne radioactive materials in nuclear facilities, ANSI N13.1, 1969, 25:57712
  physical inventories of nuclear materials, ANSI N15.3-71, 25:57715
  radiation protection, review of development of ICRP, 25:58024 (CONF-711104-1)
  radioactive waste disposal into sea, Safety Series No. 5, 1961, 25:57708
  record and reporting units for nuclear materials control, ANSI N15.2-71, 25:57716
  reference radiographs for heavy-walled steel castings, ASTM E280-68, 25:57684
  reference radiographs for steel castings up to 2 in. in thickness, ASTM E71-71, 25:57694
  reference radiographs for steel fusion welds, ASTM E390-69, 25:57687
  reference radiographs for steel welds, ASTM E99-63, 25:57683
  safe handling of radioisotopes, Safety Series No. 1, 1962, 25:57709
  samples issued in USSR on, handbook of, 25:57297(T) (NBS-SPEC. PUBL.-260-30)
  shipping of dangerous goods by railway in UK, BR 22426 (Rev.), 25:57713
  specification for straight-beam ultrasonic examination of plain and clad steel plates for special applications, ASTM A578-71, 25:57695

STANFORD LINEAR ACCELERATCR
  experimental facilities at, design of proportional wire chamber electronics system using CAMAC, 25:59656
STAR CLUSTERS
  photometry cf Ba 8, Ba 9, and Be 68 groups, three-color, (E), 25:58439
  stability of glcbular, (T), 25:58430
  star distribution in M56, bright-, (E), 25:58429
  star membership probabilities in open, method for computing, (E), 25:58437
  star velocity distribution function in quasi-stationary spherical, (T), 25:58428
  stellar distribution in M13, evolving, spatial, (E), 25:58487
  structure of rapidly rotating relaxed globular, (T), 25:58494
STARS
  atmosphere cf epsilon Vir, line-blanketed model, (T), 25:58484
  atmospheres of hot, population of states of helium atom in, (T), 25:58472
  atmospheres of pulsating, (E/T), 25:58485
  atmospheres of, circulation in radiative, (T), 25:58518
  atmospheres of, excitation and transfer of line radiation in, (T), 25:59041
  atmospheres cf, radiative transfer in, (T), 25:58510
  atmospheric parameters for G and K giant, (E/T), 25:58481
  black hole in beta Lyrae, (E/T), 25:58497
  classificaticn of CD -42° 14462 as a possible white dwarf, (E), 25:58456
  color indices fcr 28 visual binary, (E), 25:58457
  compositicn of G and K giant, (E/T), 25:58481
  distance to LkHa-101, (E), 25:58504
  distances tc Wclf--Rayet, associated with H II regicns, (E), 25:58477
  distributicn in galaxies, (T), 25:58636
  distribution of evolving, in M13, space, (E), 25:58487
  distributicn of young Pcpulation I, in spiral galaxies, (T), 25:58646
  element abundances in Am, of chromium, iron, and titanium Am, (E/T), 25:58438
  element abundances on surfaces of peculiar A, (E/T), 25:58462
  energy distributions for Orion B, (E), 25:58503
  evolution of halo population variable, in instability strip, (T), 25:58440
  evolution of M31 disk population, (E/T), 25:58491
  evolution cf massive main-sequence, (T), 25:58434
  flares from red-dwarf, (T), 25:58443
  fluorescence phenomena in, (E/T), 25:58519
  formaticn in nucleus of Milky Way, (E/T), 25:58624
  formation of binary, Deser--Laurent theory of gravitation fcr general rate of, (T), 25:59585
  helium abundance in C and B, (T), 25:58472
  helium burning in, element production from, (E/T), 25:58508
  helium productien in massive main-sequence, (T), 25:58434
  identificaticn cf HD 226868 with Cyg X-1, (E), 25:58554
  infrared spectra of LkHa-101, near-, (E), 25:58504
  light curves for MN Cas, XZ Per, and FK Aql, (E), 25:58427
  light polarization of, wavelength dependence of interstellar, (E), 25:58488
  limb darkening in eclipsing variable, nonlinear effects of, (T), 25:58490
  lumincsities of southern carbon, visual and infrared, (E), 25:58500
  luminosity cf very high-temperature, (T), 25:58433
  magnitudes cf 28 visual binary, (E), 25:58457
  mass exchange in binary, containing a neutron star, (T), 25:58424
  mass exchange in U Cep, (E), 25:58435
  mass losses from rotating magnetic, pulsed, (T), 25:58431
  mass ratio fcr beta Lyrae, (E/T), 25:58497
  matter in, superdense, (T), 25:58520
  membership cf HD 148321 and HD 119674 in Sco--Cen associaticn, (E), 25:58502
  model for Cyg X-3 featuring white-dwarf, (E/T), 25:58552
  model for eclipsing binary, 25:58499
  model for HS Herculis, (E), 25:58452
  model fcr W Vir, (E/T), 25:58485
  models fcr helium-burning 10 solar mass Population I, (T), 25:58465
  molecular dissociative equilibrium in delta Scu, (E), 25:58479
  neutrino emission from hot dense, URCA process in, (T), 25:58492
  orbital elements of spectroscopic binaries HD 24733 and HD 861, (E), 25:58442
  oscillaticns of magnetic polytrope, (T), 25:58507
  oscillations of, second-order rotational perturbaticn of nonradial, (T), 25:58441
  periods for three peculiar A-Type, (E), 25:58454
  photometric observations of LkHa-101 and LkHa-190, infrared, (E), 25:58505
  photometric orbital elements of eclipsing binary, (E), 25:58427
  photometry of HS Herculis, UBV, (E), 25:58452
  photometry cf IU Aur, UBV, (E), 25:58475
  photometry cf cld disk population red-giant, (E), 25:58449
  photometry of red RR Lyrae variable DK Vel, (E), 25:58453
  photometry of S Vel, UBV and Hβ, (E), 25:58478
  photometry of subluminous B-Type, CD -42° 14462, (E), 25:58456
  photometry of wide physical binary, (E), 25:58480
  pressure inside rotating relativistic, (T), 25:58486
  pulsations of massive main-sequence, (T), 25:58434
  radial velocities for four suspected spectroscopic binary, in the Pleiades, (E), 25:58458
  radiation transfer problems in atmospheres of, non-LTE, (T), 25:58467
  radiative transfer in atmospheres of pulsating variable, (T), 25:58543
  radiative transfer in atmospheres of, grey, (T), 25:58471
  radiative transfer in atmospheres of, modified Feautrier method for, 25:58470
  radiative transfer in model atmosphere of, (T), 25:58469
  radiative transfer in two-component atmospheres of, (T), 25:58468
  radiative-transfer effects in atmospheres of Cepheid, (E/T), 25:58474
  radio emission from hydroxyl in long-pericd variable, search for, (E), 25:58466
  radius of Sirius B, (E), 25:58511
  redshift of Sirius B, gravitational, (E), 25:58511
  reflection effect in close binary, monochromatic, (E/T), 25:58451
  relation of Wolf--Rayet, with H II regions, (E), 25:58477
  relation of zeta Oph to galactic continuum Loop I, (E/T), 25:58628
  rotation in post-Newtonian approximation to general relativity, rapid, 25:58495
  rotation of components of U Cep, (E), 25:58435
  rotation of supermassive, in first post-Newtonian approximation to general relativity, (T), 25:58496
  spectra of CH Cyg during 1967--70 activity phase, (E), 25:58482
  spectra of double-lined eclipsing binary, metallic-line, (E), 25:58506
  spectra of early O and Of, (E), 25:58483
  spectra of Orion B, (E), 25:58503
  spectra of RZ Pegasi, detection of technetium lives in, (E), 25:58459
  spectra of VI Cyg No. 12, search for interstellar absorption in, (E), 25:58512
  spectra of white-dwarf, with circular polarization, (E), 25:58447
  spectral classification of A- and F-Type, (E/T), 25:58438
  spectral emission lines for HD 21242, (E), 25:58461
  spectral emission lines of Of, time variations in, (E), 25:58515
  spectral energy distributions of main-sequence, (E), 25:58517
  spectral line formation in pulsating variable, (T), 25:58543
  stability of, undergoing phase change, (T), 25:58425
  surface gravities of A and F, in delta Scuti region, (E), 25:58476
  temperature of Sirius B, effective, (E), 25:58511
  temperatures of A and F, in delta Scuti region, effective, (E), 25:58476
  turbulence in A and F Type, micro, (E/T), 25:58438
  ultraviolet colors of early-type, interstellar extinction of, 25:58489
  ultraviolet radiation from, (E), 25:58445
  velocity observations of Delta Scuti 20 CVn, radial, (E), 25:58460
  velocity variation of, in quasi-stationary spherical cluster, (T), 25:58428
STATISTICS
  analogies between statistical mechanics and Euclidean quantum field theory, 25:59622
  Markov approach to density fluctuations due to transport and scattering, 25:59236
  Markov approach to density fluctuations due to transport and scattering, 25:59237
  parastatistics with variable numbers of particles, quantized, 25:59561
STEAM
  corrosive effects on Hastelloy N, 25:58168 (ORNL-4676, pp 139-233)
  quality in power boilers, rhenium-186 tracer method for measuring, 25:57674
  use in cooling casks and waste containers, 25:57706 (ORNL-TM-3545)
STEAM-GENERATING HEAVY-WATER-MODERATED REACTOR
  pressure tubes for, replacement procedures for, 25:60079
STEAM POWER PLANTS
  construction of, delays in schedules for, 25:59893
  operating cost of, probabilistic model for estimating, 25:60280 (ORNL-TM-3549)
  operation in mixed generation utility systems, control optimization of, 25:59922
STEEL
  analysis for nickel by neutron activation and

XUM

  radiochemical separation, 25:57381
  analysis for uranium as carbonate complex, polarographic, 25:57321
  carburization-decarburization processes in liquid sodium systems, kinetics of, (E), 25:60058(R) (ANL-7817)
  crack initiation and growth in Type A516 carbon, effects of low-cycle fatigue on, (E), 25:60061(R) (GEAP-10207-24)
  defects in castings of, to 2 in.-thick, standard reference radiographs for identification of, 25:57694
  defects in fusion welds of, standard reference radiographs for identification of, 25:57687
  defects in heavy-walled castings of, standard reference radiographs for identifying, 25:57684
  defects in welds of, standard reference radiographs for identifying, 25:57683
  evaluation of austenitic and ferritic, for use in sodium--sodium heat exchangers, 25:57614 (KFK-1387)
  heat treatment of Type 4340, using molten glass, 25:58199
  inspection of clad and plain plates of, standard for straight-beam ultrasonic method for, 25:57695
  preparation of high-speed tool, by hot isostatic pressing, 25:58197
  production of, use of process heat reactors for, 25:60200
  properties of pressure vessel, effects of thickness on mechanical, 25:60075
  properties of pressure vessel, for Czechoslovak power reactors, 25:58216 (ZJE-106)
  properties of thick-section plate and weldments of ASTM A533B, impact and tensile, 25:58218
  radioinduced void formation in, theory of, 25:58314
  tensile properties of six-inch thick flawed heavy-section ASTM A533, facility and mechanics for testing, 25:58219
  welded joints in, beta radiographic inspection of, 25:57700
  welding to aluminum, copper, and copper alloys, deposition of intermediate layers for, 25:58204
STELLAR FLARES
  emission from red dwarfs, (T), 25:58443
STELLAR WIND
  equations for, transformation of, (T), 25:58463
STELLARATORS
  magnetic fields of linear, vacuum, (T), 25:59074 (IPP-1/119)
  plasma adiabatic compression in, (T), 25:58964
  plasma diffusion in L-1, effects on charged particle streams on, (T), 25:58975
STEROIDS
  radiation effects on content in plasma of rats, bremsstrahlung, 25:58107
STOMACH
  scintigraphy of wall of, using metastable technetium-99-labeled pertechnetate, 25:58060
STORAGE RINGS
  beam expansion by coupling of betatron oscillations and damping of synchrotron oscillations, 25:59645(T) (SLAC-Trans-134)
  beam stability in, study of stochasticity in many-dimensional nonlinear oscillating systems for determining, 25:59652
STRATOSPHERE
  cyclones in lower, effects on Jan. 1964 fallout deposition on North America, 25:57572(R) (COO-1340-24)
  fission product content during 1970, 25:57980(R) (HASL-245)
  plutonium-238 content during 1970, 25:57980(R) (HASL-245)
  strontium-90 content of northern hemisphere, estimates for 1967 to 1970, 25:57579
  trough development at solar-activity maximum and minimum, relation with geomagnetic storms, (E), 25:58860
STREPTOMYCIN
  effects on frequency of x-radioinduced mutations in spores of Actinomyces hygroscopicus, 25:57964
STRESS
  analysis of, finite element method for, 25:60142
STRONTIUM
  determination in Roanoke River water by neutron activation and γ spectrometry, 25:57395
  determination in seawater by atomic absorption spectrophotometry, 25:57310
  determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
  electron reactions up to 1 keV with, total cross sections for ionization in, (E), 25:58777
  precipitation with bone mineral analog calcium hydroxylapatite by isomorphous cocrystallization, 25:57418
  separation from yttrium by colloid formation and filtration, 25:57352
STRONTIUM BROMIDES
  hexane--$SrBr_2$, bromine-80m isomeric transition in, reactions of recoils from, 25:57494
STRONTIUM ISOTOPES Sr-88
  helium-3 reactions (He-3,d) at 24.78 MeV, DWBA analysis of differential cross sections and spectrum from, (E), 25:59750
STRONTIUM ISOTOPES Sr-89
  determination in reactor effluent water by ion exchange and γ spectroscopy or radiochemical methods, 25:57351
  distribution in skin tissues following cutaneous application, 25:57917
STRONTIUM ISOTOPES Sr-90
  content in Japanese atmosphere, 1963 to 1971, 25:57579
  content in northern hemisphere stratosphere, estimates for 1969 to 1970, 25:57579
  content of milk in Europe, New Zealand, and USA during 1970, 25:57980(R) (HASL-245)
  content of plants and soils in East Germany from 1960 through 1963, effects of fallout on, 25:57986
  determination in natural samples by precipitation from EDTA solutions and counting, 25:57366
  determination in reactor effluent water by ion exchange and γ spectroscopy or radiochemical methods, 25:57351
  determination in urine, methods used at CNEN for, 25:57347 (RT/PROT-(71)9)
  determination in yttrium-90 samples, rapid method for, 25:57352
  effects on incidence of osteosarcomas in beagle dogs following intravenous injection, 25:57918
  excretion and retention time in man following acute or chronic intake, method for calculation of, 25:57919
  preparation of beta sources of, Elan-2B pilot plant for, 25:57482(T) (ORNL-tr-2535)
STRONTIUM NITRATES
  HNO_3--$Sr(NO_3)_2$, radiolysis of citric acid in solutions of, γ, 25:57457 (ARH-2163)
STRONTIUM OXIDES
  ion transport numbers for, at 900 to 1180°C under low oxygen potentials, effects of ion radius on, 25:58379
STRUCTURES
  response to ground motions, analytical method for calculating linear dynamic, 25:57592 (JAB-99-70)
  stress analysis of power reactor, finite element method for, 25:60142
STYRENE
  radioinduced polymerization in bulk and solution, γ, 25:57450 (ORO-3667-1)
  radioinduced polymerization in carbon tetrachloride or hexachlorobutadiene solution, effects of additives on kinetics of γ, 25:57454
  reactions with solvated electrons, rate constant of, 25:57475
STYRENE POLYMERS
  radiation effects on, gamma, 25:58416(R) (RLO-2098-2)
  carbon black--polystyrene, radiation effects on composites of, gamma, 25:58416(R) (RLO-2098-2)
  poly(divinylbenzene)--polystyrene, properties as carrier of stationary phase in chromatographic separations, 25:57527 (UJV-2557-Ch)
SUCROSE
  radiation effects on metabolism in pea and wheat plants and their offspring, gamma, 25:57931
  betaine--sucrose, use as release agent for evaporative production of carbon thin films, 25:58346 (CONF-711002-, pp 144-6)
SULFONES
  polymers, radiation effects on, gamma, 25:58416(R) (RLO-2098-2)
  glass fibers--polysulfones, radiation effects on composites of, gamma, 25:58416(R) (RLO-2098-2)
SULFUR
  determination in mixed oxide fuels, spectrophotometric, 25:58344(R) (LA-4693)
  meson (μ^-) capture by, asymmetry coefficient for low-energy neutron angular distribution from, (E), 25:59738 (JINR-P1-6029)
  neutron elastic and inelastic scattering at 7.96 and 9.05 MeV by natural, cross sections for, (E/T), 25:59770
  reactions with coal tar pitch, mechanisms of, 25:58168 (ORNL-4676, pp 139-233)
SULFUR DIOXIDES
  sodium-atom reactions at 1 to 30 eV with, light emission and excitation cross sections for, (E), 25:58749
SULFUR IONS
  effects on subsequent valence distribution of sulfur-35 ion implanted in sodium chloride crystals, 25:57503
SULFUR ISOTOPES S-32
  energy levels of, calculation for α-hole, 25:59757
SULFUR ISOTOPES S-35
  radiation effects on valence distribution of ion-implanted, in sodium chloride crystals, γ and heavy-ion, 25:57503
  reactions of recoil, 25:57442
SULFUR SYSTEMS
  Li--S, phase studies of, 25:58387(R) (ANL-7823)
SULFURIC ACID
  analysis of analytical grade, for impurities by neutron activation, 25:57379
  determination in fuel solutions of JRR-1, 25:57320
SUN
  activity of, correlation with interplanetary plasma and magnetosphere, (E/T), 25:58886
  activity of, effect on magnetic-storm-related atmospheric trough development, (E), 25:58860
  activity of, effect on relation of sunspot number and slowly varing component of radio emission, (E/T), 25:58614
  charged-body ejection by, formation of planets from, (T),

25:58591
  chlorine abundance in, (E), 25:58593
  light bending near, effects of torsion on, (T), 25:59605
  magnesium isotope abundances in atmosphere of, (E), 25:58597
  radio polarization at 7.8 GHz of, mapping of, (E), 25:58620
  radio-wave deflection in gravitational field of, (E), 25:58662
  rotation of, differential, 25:58622
  spectra of, iron lines in, (E), 25:58595
  spin-down of, e-folding time for, (E), 25:58581
  ultraviolet spectra during eclipse of Mar. 7, 1970, (E), 25:58617
  x-ray spectra of, satellite lines in, (E), 25:58583
SUNSPOTS
  activity in 1966, solar-flare prediction from, (T), 25:58592
  activity of 1954 minimum, relation to anomaly of streaming-associated cosmic-ray solar diurnal variation, (E), 25:58824
  book: Studies of Atmosphere and Ionosphere at Times of Unusual Solar Activity, (E), 25:58893
  effects of cycle of, on interplanetary hydrogen cone, (T), 25:58578
  magnetic fields in, (T), 25:58584
  magnetic-field strengths in, effects on molecular dissociation equilibrium, (E/T), 25:58589
  models of, hydromagnetic, (T), 25:58584
  radio polarization in McMath 11002 region, (E), 25:58620
  relation of numbers of, to slowly varying component of solar radio emission, (E/T), 25:58614
  spectra of umbrae of, molecular, (E/T), 25:58577
  spectra of, chlorine in, (E), 25:58593
  velocity field in and around, (E), 25:58598
SUPERCONDUCTORS
  critical field of solid cylinder of, with normal metal coating, (T), 25:58941
  electric conductivity of, higher-order effects due to fluctuation on, 25:58930
  feasibility of high-temperature, 25:58934
  fluctuation effects on S/I/N junction current, 25:58936
  fluctuation of order parameter and diamagnetism of, dynamic, 25:58945
  Josephson device impedance matching, dc transformer for, 25:58938
  resonance scattering in two-band, nonmagnetic, (T), 25:58935
  surface resistance of dirty Type-II, 25:58946
  theory of phase transitions in β-tungsten structure of A_3B intermetallic, induced by band Jahn--Teller effect, 25:58272
  tunneling in, role of spin-orbit scattering in high-field, (T), 25:58939
SUPERFLUIDITY
  examples of off-diagonal long-range order in, explicit, (T), 25:58918
SUPERNOVA REMNANTS
  mapping of Cygnus Loop at 1420 MHz, (E), 25:58514
  occurrence in galactic continuum loops, (E/T), 25:58628
  structure of Cygnus Loop at 1420 MHz, (E), 25:58514
  x-ray flux from Cas A, soft, (E), 25:58548
SUPERNOVAE
  discovery of faint, in anonymous southern galaxy, (E), 25:58455
  distribution in spiral galaxies, (T), 25:58646
  photometry of SN 1971, UBV, (E), 25:58464
  spectra of Type-I, wavelength shifts of intensity minima in, (E), 25:58501
SURFACE WATERS
  sodium-22 content of inland, hydrological studies using cosmogenic, 25:57568
  tritium content of USA, during 1970, 25:57991
SURFACES
  electrostatic potential of real conducting, statistical variations in, (T), 25:58681
  gas-beam reactions with hot solid, harmonic-model analysis of, 25:58690
SURRY POWER REACTOR, UNIT 1
  piping systems for, applications of sensitized stainless steel in, 25:59962 (DOCKET-50280-52)
  piping systems for, applications of sensitized stainless steel in, 25:59960 (DOCKET-50280-50)
  piping systems for, request for additional data on welds for, 25:59961 (DOCKET-50280-51)
  quality assurance program for construction of, request for additional data on, 25:59961 (DOCKET-50280-51)
SURRY POWER REACTOR, UNIT 2
  piping systems for, applications of sensitized stainless steel in, 25:59962 (DOCKET-50280-52)
  piping systems for, applications of sensitized stainless steel in, 25:59960 (DOCKET-50280-50)
  piping systems for, request for additional data on welds for, 25:59961 (DOCKET-50280-51)
  quality assurance program for construction of, request for additional data on, 25:59961 (DOCKET-50280-51)
SUSPENSIONS
  x-ray scattering from, effects of particle size on Compton and Rayleigh, 25:59118
SUSQUEHANNA POWER REACTOR, UNIT 1
  design parameters of, requested additional data on, 25:59999 (DOCKET-50387-11)
  design parameters of, revised and additional data on, 25:59998 (DOCKET-50387-10)
  operations aspects of, requested additional data on, 25:59999 (DOCKET-50387-11)
  operations aspects of, revised and additional data on, 25:59998 (DOCKET-50387-10)
SUSQUEHANNA POWER REACTOR, UNIT 2
  design parameters of, requested additional data on, 25:59999 (DOCKET-50387-11)
  design parameters of, revised and additional data on, 25:59998 (DOCKET-50387-10)
  operations aspects of, requested additional data on, 25:59999 (DOCKET-50387-11)
  operations aspects of, revised and additional data on, 25:59998 (DOCKET-50387-10)
SWEDEN
  fallout monitoring in atmosphere of, following 10th Chinese nuclear explosion, 25:57580
  nuclear power plant development in, 1970 status of, 25:59890
SWINE
  radiation effects on serum content of immunoglobulins in, γ, 25:58104
SWITCHES
  development of gas-discharge duplexers using radioactive primers, 25:57902
SWITZERLAND
  radioactivity levels in human food in, during 1969, 25:57989
  radioactivity levels in human food in, during 1970, 25:57988
SYMMETRY GROUPS
  breaking of Nambu--Goldstone chiral, for baryon octet electromagnetic mass differences, 25:59541
  chiral and conformal Lagrangian models in, 25:59542
  GL(n), characteristic identities for generators of, 25:59537
  internal, compatibility with asymptotic identification for electromagnetic part of gauge field, 25:59545
  O(3), boson calculus for, operators in, 25:59534
  O(3), finite- and infinite-dimensional local irreducible representations of, 25:59536
  O(4), boson calculus for, operators in, 25:59534
  O(4,2) x SU(3), baryon mass and electromagnetic form factors in, 25:59548
  O(n), boson calculus for, operators in, 25:59534
  O(n), characteristic identities for generators of, 25:59537
  SO(n), polynomial identity for vector operators for Lie algebra of, 25:59538
  SO(p,1), decomposition of matrix elements for most degenerate representations of, 25:59535
  Sp(n), boson calculus for, operators in, 25:59534
  Sp(n), characteristic identities for generators of, 25:59537
  SU(3) x SU(3) breaking model, π sigma commutator in, 25:59550
  SU(4) x O(3), classification of meson states in representations of, 25:59551
  U(6) x U(6), duality and representation mixing for hadron interactions in nonchiral, 25:59549
  U(6,6), meson classification and mass formulas in ladder, 25:59546
SYMMETRY GROUPS SU(3)
  baryon resonance decay rates and coupling constants in, 25:59491
SYNCHROCYCLOTRONS
  radiofrequency circuit for, 25:59649(P)
  shielding for JINR, activation of concrete, 25:59657
SYNCHROTRON RADIATION
  polarization of, degree of circular, (T), 25:58547
SYNCHROTRONS
  control and data handling system for NAL 8-GeV injection booster, computer-based, 25:59664
SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP)
  shielding for reactor, discrete ordinates analysis of bottom grid-plate, (E/T), 25:60055(R) (ORNL-TM-3573)
SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-8)
  boiler for, performance testing of SN-1, 25:60138 (N-71-19497)
  boilers for, thermal performance of once-through forced convection mercury, (T), 25:60194 (N-71-27855)
  cooling system for, radioisotope transport in, 25:58166(R) (AI-AEC-12980)
  pump and turboalternator for, design and performance of bearings for, 25:57617 (N-71-26910)

T

T-111 (TANTALUM ALLOY)
  mechanical properties at high temperatures, effects of oxygen doping on, 25:57658(R) (ORNL-4723)
TACHYONS
  energy levels in magnetic field, 25:59388
  group theory for, lightlike, continuous-spin, and spacelike representations of Poincare group in, (T), 25:59532
  properties of photon, in disappearing Fresnel wave, strong correlation between Cherenkov effect and, (T), 25:59573

theory for classical, charged, point, mechanics and classical tunnel effect in, (T), 25:59556 (IPP-6/95)

TALCS
  effects on thermostability of irradiated polyethylene, 25:57446

TANTALUM
  determination by spectrography, elimination of effect of sample composition on, 25:57330
  determination in ore dressing products by x-ray absorption methods, 25:57327
  determination in pyrolytic graphite by neutron activation and counting of delayed β and γ coincidences, 25:57389
  determination in silicate rocks by neutron activation, low-energy photon detector for, 25:57387
  determination in sphene by neutron activation and γ spectroscopy, 25:57371
  determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
  effects on electric properties of lanthanum boride, temperature dependence of, 25:59183
  effects on electric properties of lanthanum hexaboride, 25:59182
  electron reactions at 12.5 to 22 MeV with, bremsstrahlung yield from, 25:59106
  etching by selective cavitation, method for, 25:58190
  mechanical properties of, effects of nitridation at 1000 to 1400°C on, 25:58259
  photon reactions with, secondary electron emission from, (E/T), 25:59107
  preparation of radiation targets of, by argon ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
  preparation of spheroidized powders of, using plasma heating, 25:58187(T) (SCL-T-710281)
  radiation damage in films of nitrogen- and oxygen-doped, low-temperature 150-keV proton, 25:59160
  radioinduced Frenkel defects in (110) foils of, anisotropy of swelling energy of electron, 25:59125 (JUL-729-FF)
  separation from oxalic and tartaric acids by solvent extraction using tributylamine, 25:57546
  solvent properties for nitrogen at high temperatures, 25:58249
  surface energy and work function of smooth faces of monocrystal of, (T), 25:59194
  thermal emission properties of bare monocrystalline and barium-covered, 25:59177

TANTALUM ALLOYS AND SYSTEMS
  Ta--Ti-base, corrosion resistance of joints of, in hydrochloric acid at 90°C, 25:58176
  Ta--Ti-base, weldability of, 25:58176
  Ta-base--W, mechanical properties at high temperatures, effects of oxygen doping on, 25:57658(R) (ORNL-4723)

TANTALUM CARBIDES
  crystal structure of systems of, electron microscopy and optical studies on relation of physical properties to, 25:58403
  machining of, effects of carbon content in corresponding ranges of homogeneity on electroerosion, 25:58356
  stress variations in, at 1200 to 2200°C, effects of deformation rate on, 25:58395

TANTALUM ISOTOPES Ta-181
  neutron capture at 30 keV to 1.4 MeV, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801
  photofission at 0.1 to 5 GeV, giant resonance in yields and integral cross sections for, (E), 25:59794
  proton reactions (p,γ) at 4 MeV, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801

TARS
  reactions with sulfur, mechanisms of, 25:58168 (ORNL-4676, pp 139-233)

TD-NICKEL
  testing of fuel capsules of, at 850 to 1000°C, results of long-term, 25:57654(R) (DP-1279)

TD-NICKEL CHROMIUM
  fabrication of thin sheets and tubes of, development of method for, 25:58199
  testing of fuel capsules of, at 1000°C, results of long-term, 25:57654(R) (DP-1279)

TECHNETIUM
  spectral lines of, in RZ Pegasi, (E), 25:58459

TECHNETIUM ISOTOPES Tc-99
  chemical state in seawater, effects of iron on, 25:57410
  effectiveness of sulfur colloid-incorported metastable, for scanning liver for diagnosis of adenomas, 25:58046
  evaluation of albumin macroaggregate-incorporated metastable, for scintigraphy of blood circulation and neoplasm localization in human lungs, 25:58040 (UCLA-12-834)
  evaluation of pertechnetate- and sulfur colloid-incorporated metastable, for diagnostic scintigraphic studies, 25:58060
  separation of metastable, from molybdenum-99 by solvent extraction and ion exchange, 25:57483
  use of colloids of metastable, for scintigraphy of reticuloendothelial system in man with blood diseases, 25:58053
  use of metastable, for scintigraphy of human brain for diagnosis of Schilder's disease, 25:58048

TEKTITES
  age of Ivory Coast indochinite and micro-, relations of geomagnetic reversals to fission track estimation of, 25:57565

TELEMETERING SYSTEMS
  design parameters for magnetic, 25:60245(P)

TELEVISION EQUIPMENT
  use for scintiscan reproduction for contrast intensification, 25:58059
  x-ray emission from color, estimation of genetically significant dose for population of USA from, 25:58011

TELLURIUM
  analysis for silicon after extraction with TBP, spectrophotometric, 25:57324
  analysis for trace amounts of selenium by photometry, 25:57323
  determination simultaneously with gold and selenium in water by neutron activation, 25:57370
  determination using sodium azide as supporting electrolyte, polarographic, 25:57307
  effects on complexonometric determination of rare earths, 25:57317

TELLURIUM ISOTOPES Te-122
  neutron reactions (n,α) at 14.2 MeV, presence of direct effects in spectra from, (E/T), 25:59802

TELLURIUM ISOTOPES Te-130
  carbon-12 reactions (C-12,xn) and (C-12,αxn) above 10 MeV/nucleon, excitation functions, compound nucleus production cross section energy dependence, angular momentum, and evaporation cross section ratio energy dependence for, (E), 25:59779 (JINR-P7-5912)
  carbon-13 reactions (C-13,xn) and (C-13,αxn) above 10 MeV/nucleon, excitation functions, compound nucleus production cross section energy dependence, angular momentum, and evaporation cross section ratio energy dependence for, (E), 25:59779 (JINR-P7-5912)

TELLURIUM ISOTOPES Te-132
  excretion and retention time in man following acute or chronic intake, method for calculation of, 25:57919

TELLURIUM OXIDES
  Na_2O--TeO_2, radiation effects on structure of glasses of, EPR studies on effects of metal oxide additions on γ, 25:57447

TELLURIUM SYSTEMS
  As--Ge--Te, radiation effects on crystal structure of glass-forming chalcogenide of, fast neutron, 25:58419
  Au--Pd--Te, superconductivity in simple cubic intermetallic (Au/sub 1-x/Pd/sub x/)Te_2, 25:58928 (CALT-822-37)
  Bi--Te, hardness of, 25:58253
  Li--Te, phase studies of, 25:58387(R) (ANL-7823)

TERBIUM
  complexes with HEDTA, dissociation constants for, 25:57537
  determination in fluorite by solvent extraction and spectrography or fluorimetry, 25:57332
  determination in silicate rocks by neutron activation, low-energy photon detector for, 25:57387
  determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
  energy level interactions in, 4f--5d, (T), 25:58697
  oxidation potential for trivalent--tetravalent, 25:57437
  photochemistry of dilute sulfuric acid solutions of, formation of hydrates of peroxides in, 25:57416
  preparation of radiation targets of, by argon ion sputtering, 25:59637 (CONF-711002-, pp 109-15)

TERBIUM IONS
  luminescence in lanthanum and cerium phosphate phosphors, effects of thorium ions on, 25:59185

TERBIUM ISOTOPES Tb-159
  neutron capture at 400 keV, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801
  neutron reactions (n,α) at 14.2 MeV, presence of direct effects in spectra from, (E/T), 25:59802

TERBIUM ISOTOPES Tb-160
  beta decay of, triple γ angular correlations from, (E), 25:59819

TEREPHTHALIC ACID, POLYETHYLENE ESTERS
  reactions with fluorine, 25:57619 (RFP-1739)

p-TERPHENYL
  effects on γ-radioinduced polymerization of styrene in carbon tetrachloride or hexachlorobutadiene solutions, 25:57454

THALLIUM
  determination by potentiometric titration using potassium chlorate, 25:57309
  diffusion of trace amounts of, in molten bismuth, indium, lead, tin, and zinc, thermal, 25:58267
  neutron capture at 400 keV by natural, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801

THALLIUM FLUORIDES
  TlF--UF_4, crystal structure of phases in, differential thermal analysis and x-ray crystallography studies on, 25:58418

THALLIUM ISOTOPES Tl-204
  beta decay of, K- and L-shell electron shake-off in, (E), 25:59792

THALLIUM SULFATES
  effects on nitrification by Nitrobacter agilis in soil

XUM

  suspension, 25:57401
- effects on yields of hydrogen and hydrogen peroxide from radiolysis of water, 25:57472

THERMAL CONDUCTIVITY
- measurement in solids by temperature wave method, description of, 25:57644

THERMIONIC CONVERTERS
- design and performance of radioisotope-fueled, parametric studies of, 25:57656 (N-71-18512)
- design with beryllium oxide reflectors and vapor chamber condensers for space reactors, 25:60197(P)
- electric space potential in cesium diode, 25:58838 (N-71-26273)
- fuel element design with heat pipe for nuclear, 25:60199(P)
- performance of CVD tungsten emitters with niobium and molybdenum collectors, 25:58839 (TEE-4125-5)

THERMODYNAMICS
- arrow of time in, (T), 25:58672
- Carnot cycles for general relativistic systems, (T), 25:58673
- conference on statistical, in astrophysics and relativity, Cardiff, Wales, 4/70, 25:58670
- ensemble versus time average probabilities in relativistic statistical mechanics, (T), 25:59238
- time asymmetry in, (T), 25:58671
- variational formulation of relativistic fluid, (T), 25:58674

THERMOELECTRIC CONVERTERS
- development of radioisotope-fueled, for spacecraft electric power systems, review on, 25:57671
- operation of cobalt-60-fueled, summary on, 25:57654(R) (DP-1279)

THERMONUCLEAR REACTIONS
- production in migmatron self-colliding orbits, 25:59078

THERMONUCLEAR REACTORS
- bibliography on plasma physics and fusion reactors, 25:58955
- data acquisition system for ORNL fusion experiments, 25:59075 (ORNL-TM-3593)
- design of JFT-1, magnet coil, 25:59079
- development of GA dc multipole and Doublet II, 25:59073(R) (GULF-GA-A-10807)
- effects on earth surface temperatures in years 2000 to 2020, 25:58956
- magnetic pumping in toroidal, transit-time, 25:58959 (CEA-CONF-1830)
- plasma confinement in toroidal, using hf electric fields, (E/T), 25:58976
- plasma diffusion in multipoles toward conductors and walls, (T), 25:58970
- plasma electric conductivity in toroidal, with trapped particles, (T), 25:59046
- plasma losses in high-current, from inverse skin effect, (T), 25:58967

THERMOSPHERE
- electron pitch-angle distribution at 350 to 1200 km in, at low latitude, (E), 25:58904
- winds in, auroral electrojet heating of, (T), 25:58864

THICKNESS GAGES
- description of charged-particle radiometric, for accurate measurements of targets, 25:57863 (CONF-711002-, pp 307-20)
- design and performance of radiometric, using semiconductor detectors, 25:57865 (NP-18941)
- design of alpha radiometric, 25:57864 (INS-TL-112)
- radiation source for gamma, selection of energy and activity of, 25:57874

THOREX PROCESS
- development for thorium reactor fuel with high burnup, 25:57541

THORIUM
- abundance on surfaces of peculiar A stars, (E/T), 25:58462
- complexes with DTPA, structure of, aqueous ir and proton NMR spectral studies of, 25:57436
- content in manganese nodules, α-particle and induced fission track methods for measuring, 25:57570
- deposition as oxide on instrument parts of stainless steel, electrolytic, 25:57440
- determination in rare earth oxides by TBP extraction and photometry, 25:57341
- determination of natural, in urine, methods used at CNEN for, 25:57347 (RT/PRCT-(71)9)
- determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
- determination of ultramicroamounts of, in rocks, photometric, 25:57342
- effects on spectrophotometric determination of calcium, 25:57304
- electromigration behavior of, in CDTA and EDTA, 25:57520 (JINR-E6-5952)
- oxidation potential for trivalent--tetravalent, 25:57437
- preparation of radiation targets of, by argon ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
- separation from other actinides by paper or thin-layer chromatography, 25:57553
- separation from other elements by ion exchange, 25:57342
- separation from rare earths and uranium by solvent extraction using TBP, 25:57341
- separation from thorium reactor fuel with high burnup by Thorex two-stage process, 25:57541
- solubility in lithium--bismuth solutions, 25:57522 (ORNL-4676, pp 234-71)
- x-ray yields from L/sub II/ subshell of, Auger, Coster--Kronig, and fluorescence, (E), 25:58719

THORIUM ALLOYS AND SYSTEMS
- Th-base--U, fabrication of fuel elements of, for unclad metal breeder reactor, 25:58185 (ORNL-TM-3499)

THORIUM CARBIDES
- chlorination of, thermogravimetric study of, 25:57542

THORIUM FLUORIDES ThF_4
- BeF_2--LiF--ThF_4, separation of cesium and rubidium from, by reductive extraction, 25:57298 (ORNL-4676, pp 73-138)
- BeF_2--LiF--ThF_4--UF_4, heat transfer and thermophysical properties of, (E/T), 25:60015 (ORNL-4676, pp 21-72)

THORIUM IONS
- effects on cerium and terbium luminescence in lanthanum and cerium phosphate phosphors, 25:59185

THORIUM ISOTOPES
- cross section measurements of, nondestructive and destructive methods of analysis used in fabrication of targets for, 25:57345 (CONF-711002-, pp 293-306)

THORIUM ISOTOPES Th-228
- effects on incidence of osteosarcomas in beagle dogs following intravenous injection, 25:57918

THORIUM ISOTOPES Th-230
- abundance variations in ocean sediments, 25:57588
- content ratio to uranium-234 in East Pacific Rise sediments and iron deposits, 25:57585
- energy levels from protactinium-230 electron-capture decay, spin--parity assignments for, (E), 25:59800
- energy-level transitions from protactinium-230 electron-capture decay, branching and mixing ratios, internal conversion coefficients, and multipolarities for, (E), 25:59800
- neutron reactions with, production of protactinium-231 and uranium-232 by, 25:57479 (BMBW-FBK-71-6)

THORIUM ISOTOPES Th-232
- determination in biological materials, alpha spectra unfolding method for, 25:57362
- neutron reactions with, production of protactinium-231 and uranium-232 by, 25:57479 (BMBW-FBK-71-6)
- photofission at 0.1 to 5 GeV, giant resonance and 300-MeV resonance in yields and integral cross sections for, (E), 25:59794
- photofission near threshold energy, angular distribution for, (E), 25:59786
- preparation of aluminum-clad foils of, method for, 25:58180 (CONF-711002-, pp 70-6)

THORIUM OXIDES
- thermal decomposition of hydrous, thermogravimetric, differential thermal analysis, and Hahn's emanation studies, 25:57407

THORIUM OXIDES ThO_2
- CeO_2--ThO_2, electric conductivity of $CeO_2 \cdot 3ThO_2$ solid solutions at 1000 to 1500°C and varying oxygen pressure, 25:58368
- Co-base--Cr--ThO_2, properties for use in turbine vanes, 25:58203
- Mo--PuO_2--ThO_2, etching of sintered, for optical microcopy, method for, 25:58354
- Mo--ThO_2, metallographic properties of cermet spheres of, 25:58388 (MLM-OP-71006)
- Mo--ThO_2, preparation of cermets of, development of cold- and hot-press sintering methods for, 25:57658(R) (ORNL-4723)
- PuO_2--ThO_2, etching of sintered, for optical microscopy, method for, 25:58354
- PuO_2--ThO_2, metallography of molybdenum-coated pressed pellets of, 25:58398
- ThO_2--UO_2, analysis for uranium and uranium dioxide stoichiometry, coulometric, 25:57305
- ThO_2--W-base, particle morphology in, effects of deformation on, 25:58264

THORIUM OXYCARBONATES
- thermal decomposition of hydrous, thermogravimetric, differential thermal analysis, and Hahn's emanation studies, 25:57407

THORIUM SULFATES
- effects on nitrification by Nitrobacter agilis in soil suspension, 25:57401

THREONINE
- radiation effects on metabolism in pea and wheat plants and their offspring, gamma, 25:57931

THULIUM
- determination in silicate rocks by neutron activation, low-energy photon detector for, 25:57387
- oxidation potential for trivalent--tetravalent, 25:57437
- preparation of radiation targets of, by argon ion sputtering, 25:59637 (CONF-711002-, pp 109-15)

THULIUM ISOTOPES Tm-169
- neutron reactions (n,α) at 14.2 MeV, presence of direct effects in spectra from, (E/T), 25:59802

THULIUM ISOTOPES Tm-174
- beta decay of, gamma spectra and half-life for, (E), 25:59781 (KURRI-TR-76, pp 19-20)

THULIUM OXIDES
- compatibility with TZM, tantalum-base alloys, and tungsten capsule materials at 1600°C, 25:57658(R) (ORNL-4723)

vapor pressure at 2000°C, 25:57658(R) (ORNL-4723)

THYMIDINE
  radiclysis cf aqueous solutions of, products from electron pulse, 25:57930

THYMINE
  radiclysis cf aqueous solutions of, products from electron pulse, 25:57930

THYMUS GLAND
  radiation effects on mouse, role of bone marrow transplants in recovery from x, 25:58115
  radiation effects on ultrastructure of cells of mouse, comparison of effects of cortisone and polyoma virus infections with x, 25:58114

THYROID GLAND
  function in gerbils, use of iodine-131 in studies of, 25:57915
  radiation effects on activity in rats, bremsstrahlung, 25:58107
  radioinduced destruction of, in rats following intraperitoneal injection of iodine-131 during gestation, 25:58100
  scintigraphy for diagnosis of neoplasms and function studies, use of iodine-131 for serial, 25:58056
  scintigraphy using selenium-75-labeled methionine for localization of lesions, 25:58054

TIN
  critical field curve of superconducting, effects of bismuth impurity on, 25:58940
  determination in biological materials by neutron activation and rapid radiochemical separation, 25:57378
  diffusion of trace amounts of thallium in molten, thermal, 25:58267
  superconducting transitions in films of, resistivity anomalies from liquid helium contact, (E), 25:58937

TIN ALLOYS AND SYSTEMS
  Al--Sn--Ti-base--V, heat treatment of, using molten glass, 25:58199
  Cu--Sn, welding to steel, deposition of intermediate layers for, 25:58204
  Mo--Sn--Ti-base--Zr, tensile properties of Beta III, at room temperature, 25:58234
  Nb--Sn, Kohn instability in Labbe--Friedel model of Nb_3Sn, (T), 25:58947

TIN ISOTOPES
  neutron pairing in, equilibrium, (T), 25:59833 (JINR-E4-5907)

TIN ISOTOPES Sn-120
  deuteron elastic scattering at 80 MeV, optical-model analysis of angular distributions from, (E), 25:59754
  deuteron inelastic scattering at 82 MeV, DWBA analysis of angular distributions from, (E), 25:59754
  energy levels from inelastic scattering, deformation parameters for, (E), 25:59754

TISSUES
  analysis of bird and fish, for mercury, by neutron activation and radiochemical separation, 25:57392
  analysis of soft, for calcium-45 by liquid scintillation counting, 25:57361
  radiation dosimetry in human, concepts and units for ionizing, 25:58002
  radiation effects on human tumor-surrounding, effects of body inhomogeneities on electron and x, 25:58141
  radiation effects on lactate dehydrogenase activity in vaginal, of cervical cancer patients, effects of dose on γ, 25:57937

TITANIUM
  abundance in Am stars, (E/T), 25:58438
  analysis for oxygen by 14-MeV neutron activation and γ spectrometry, 25:57376
  determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
  diffusion of molybdenum atoms in films of, ion--ion emission studies on, 25:58266
  effects on hardness of dispersion-hardening iron-base alloys, 25:58235
  electron reactions at 12.5 to 22 MeV with, bremsstrahlung yield from, 25:59106
  joining to high-strength materials by continuous seam diffusion bonding, 25:58201
  mechanical properties of, effects of fatigue on, 25:58223
  microstructure of, effects of fatigue on, 25:58223
  photon reactions with, secondary electron emission from, (E/T), 25:59107
  radioinduced defects in, at absolute melting temperature, electron microscopic study of fast neutron, 25:58302
  solubility in sodium at high temperatures, 25:58163(R) (AI-AEC-12859)

TITANIUM ALLOYS AND SYSTEMS
  embrittlement by ω phase formation in α + β, effects of alloying on, 25:58283
  joining to high-strength materials by continuous seam diffusion bonding, 25:58201
  preparation of reference specimens of, methods for, 25:58179 (CONF-711002-, pp 47-58)
  Al--Cr--Ni-base--Ti, radiation effects on mechanical properties of, relations of temperature with neutron, 25:58295 (FRNC-TH-64)
  Al--Sn--Ti-base--V, heat treatment of, using molten glass, 25:58199
  Al--Ti, aluminum activity in, effects of hydrogenation on, 25:58220
  Al--Ti-base--V, bonding of, method for diffusion, 25:58207
  Al--Ti-base--V, drawing of, testing of lubricants for deep, 25:58195
  Al--Ti-base--V, extrusion of thin-walled tubes of, development of method for, 25:58199
  Al--Ti-base--V, rolling of sheets of, development of method for, 25:58199
  C--Cr--Fe--Hf--Mn--Mo--Nb--Ni-base--Si--Ti--Zr, radiation effects on mechanical properties of, relations of composition with thermal neutron, 25:58168 (ORNL-4676, pp 139-233)
  Co-base--Fe--Mo--Ti, magnetic properties of wires of, 25:59197
  Cr--Ti, chromium activity in, effects of hydrogenation on, 25:58220
  Cr--Ti--V-base, radiation effects on tensile properties of, alpha particle, 25:58163(R) (AI-AEC-12859)
  D--Nb--Ti, deuterium distribution fluctuations in $NbTi_2D$, 25:58278
  Hf--Pt-base--Rh--Ti--W, hardness of crystallized, effects of annealing at high temperatures on, 25:57658(R) (ORNL-4723)
  Mo--Sn--Ti-base--Zr, tensile properties of Beta III, at room temperature, 25:58234
  Mo--Ti, thermodynamic properties at 1844 and 1900°K, triple Knudsen-cell measurements of, 25:58265
  Mo-base--Ti, radioinduced void formation in, neutron, 25:58300 (ORNL-TM-3496)
  Nb--Ti, microstructure of superconducting, effects of heat treatment on, 25:58942
  Ta--Ti-base, corrosion resistance of joints of, in hydrochloric acid at 90°C, 25:58176
  Ta--Ti-base, weldability of, 25:58176
  Ti--V, phase formation in, effects of temperature on omega, 25:58283
  Ti--V, radiation effects on deformation in, low-temperature neutron, 25:58339
  Ti--V, vanadium activity in, effects of hydrogenation on, 25:58220
  Ti--V-base, radiation effects on tensile properties of, alpha particle, 25:58163(R) (AI-AEC-12859)
  Ti--V-base, radioinduced void formation in, electron microscopic study of fast neutron, 25:58309
  Ti--V-base, radioinduced void formation in, neutron, 25:58300 (ORNL-TM-3496)
  Ti--Zr-base, properties of dilute cast, electric and mechanical, 25:58258

TITANIUM CARBIDES
  crystal structure of systems of, electron microscopy and optical studies on relation of physical properties to, 25:58403
  properties of, effects of ionic heating during diffusion welding on surface chemical and physical, 25:58233

TITANIUM CHLORIDES
  reactions with tetrakis(decyl)ammonium chloride complexes with uranyl chloride for reduction of uranyl ion, 25:57415

TITANIUM DEUTERIDES
  preparation of targets of, on copper backing, 25:59639 (CONF-711002-, pp 134-43)

TITANIUM HYDRIDES
  preparation of targets of, on copper backing, 25:59639 (CONF-711002-, pp 134-43)

TITANIUM ISOTOPES Ti-44
  energy levels of, calculation for α-hole, 25:59757
  production in stars from simple helium burning, (E), 25:58508

TITANIUM ISOTOPES Ti-46
  helium-3 reactions (He-3,t) at 37.7 MeV, DWBA analysis including tensor force of, (E), 25:57901
  neutron reactions (n,p) at 4.1 to 6.1 MeV, cross sections for, (E), 25:59755
  proton reactions (p,γ) at 1350 to 2280 keV, excitation function for, (E), 25:59752

TITANIUM ISOTOPES Ti-47
  neutron reactions (n,p) at 3.4 to 6.1 MeV, cross sections for, (E), 25:59755

TITANIUM ISOTOPES Ti-48
  helium-3 elstic scattering at 30 and 32 MeV, optical-model analysis of differential cross sections for, (E), 25:59769
  neutron reactions (n,p) at 6.1 MeV, cross section for, (E), 25:59755
  proton elastic scattering at 40 MeV, differential cross sections for, (E), 25:59739 (ORNL-TM-3591)

TITANIUM OXIDES
  dissociation energy of, 25:57435(R) (COO-1029-39)
  effects on thermostability of irradiated polyethylene, 25:57446
  CaO--Nb_2O_5--SiO_2--TiO_2, liquidus of pseudo-ternary $CaO.Nb_2O_5$--$CaO.TiO_2$--SiO_2 plane of, 25:58390

TITANIUM TRITIDES
  preparation of targets of, on copper backing, 25:59639 (CONF-711002-, pp 134-43)

TOKAMAK DEVICES
  magnetic field effects on plasma cross section in, equilibrium, (T), 25:59077
  plasma confinement in, energy flow and current diffusion

XUM

in, (T), 25:58961 (CONF-711016-1)
- plasma current distribution measurements using alpha particles, (T), 25:58980 (JAERI-Memo-4531)
- plasma diagnostics in medium-beta torus JFT-2, microwave interferometric, (E), 25:58979 (JAERI-Memo-4530)
- plasma energy losses in, effects of effective electron collision frequency on, (E), 25:58974
- plasma heating by high-frequency fields in, (T), 25:58966
- plasma instabilities in, collisional effects on dissipative, (T), 25:59060 (CEA-CONF-1800)

p-TOLUAMIDE, N-ISOPROPYL-α-(2-METHYLHYDRAZINO)-
- hydrochloride, effects on survival of Azotobacter chroococcum, effects of cell age and content on, 25:58156

TOLUENE
- radioinduced polymerization of, effects of recoil atoms of carbon-14 produced from incorporated aluminum nitride on neutron, 25:57456

TRACER TECHNIQUES
- book: Handbook for Technologists of Nuclear Medicine, 25:58049
- method for measuring steam quality in boiler tubes using rhenium-186, 25:57674
- method for refractory furnace lining wear using radioisotopes, 25:57677
- use of barium-133 and calcium-45, to study losses from oxide coatings on lamp cathodes, 25:57660
- use of lanthanum-140, for measuring mixing efficiency of sintering facility for producing iron agglomerate, 25:57659

TRANSACTINIDE ELEMENTS
- abundance on surfaces of peculiar A stars, (E/T), 25:58462
- alpha decay of, Nilsson-model calculation of half-lives for, (T), 25:59803
- electron energy eigenvalues and wave functions in, effects of upper limit to electric field strength on, (T), 25:59554
- fission of, Nilsson-model calculation of barriers and half-lives for spontaneous, (T), 25:59803
- production of, survey of possibilities for, (E/T), 25:59774(T) (AERE-Trans-1139)

TRANSDUCERS
- development of broadband high-temperature magnetostrictive and piezoelectric ultrasonic, for reactor measurements, 25:57898

TRANSFORMERS
- design for accelerator tube, 25:59648(P)
- design of superconducting, for impedance matching of Josephson galvanometer, 25:58938

TRANSISTORS
- carrier transport in bipolar, for high frequency and storage time predictions, TRAC Ebers--Moll model for, 25:57904
- radiation effects on gallium arsenide junction field-effect, improved tolerance to fast-neutron, 25:57905

TRANSPORT THEORY
- Boltzmann equation for, properties of numerical approximations for, 25:59113
- conference on interdisciplinary applications of, Oxford, England, 9/70, 25:59109
- equations, fundamental eigenvalues of linear, 25:59683
- Feautrier method in, modified, (T), 25:58470
- Fourier transform methods in linear, 25:59121
- Milne problem for two-dimensional, in quarter space, 25:59112
- multigroup equation for, with separable kernel, 25:59111
- radiative transfer equation in, solution of energy equation and, 25:58851
- radiative transfer in, Bellman's approach to numerical solution of Fredholm integral equations with positive kernels, 25:59110
- radiative, grey, (T), 25:58471
- radiative, in stellar atmospheres, (T), 25:58510
- radiative-transfer equation for, numerical solution of unsteady, 25:59114

TRANSURANIUM ELEMENTS
- separation by electromigration in CDTA and EDTA, 25:57520 (JINR-E6-5952)
- separation from HFIR targets in TRU, 25:57524 (ORNL-TM-3343)
- separation from lanthanum by electromigration, 25:57520 (JINR-E6-5952)
- separation of berkelium from, by sorption on zirconium phosphate--silicate, 25:57530

TRAPS
- performance in removing impurities from lithium in heat pipes, 25:57615(R) (LA-4746)

TRIBUTYLAMINE
- solvent properties for niobium, protactinium, tantalum, and zirconium, 25:57546

TRIMETHYLENE OXIDE
- iodine-ion reactions at 12 MeV with, electron-capture and -loss cross sections for, (E), 25:58768

s-TRIOXANE
- radioinduced polymerization of solid, kinetics of γ, 25:57453
- reactions with solvated electrons, rate constant of, 25:57475

TRIOXANES
- radioinduced polymerization under superdry conditions, γ, 25:57450 (ORO-3667-1)

TRITIUM
- activity of, method using proportional counter for measurement of absolute, 25:57505
- binding energy of, effect of charge asymmetric potentials on, (T), 25:59701
- content in off-site water supplies following Schooner Event, (E), 25:57574 (PNE-524)
- determination by combustion in nitrogen stream, oxidation, and scintillation counting, 25:57349
- determination in MSRE pump bowl gas, 25:57298 (ORNL-4676, pp 73-138)
- determination in urine, methods used at CNEN for, 25:57347 (RT/PROT-(71)9)
- determination of, evaluation of 5 scintillators for use in, 25:57363
- deuteron reactions (d,n) at 0.2 to 1 MeV using polarized beam, analyzing power for, (E), 25:59705
- deuteron reactions (d,n) at 0.5 to 7 MeV, compound-nucleus analysis of differential and total cross sections and neutron polarization from, (T), 25:59706
- deuteron reactions (d,n) with, formalism for polarized particles in, (T), 25:59837 (LA-4492)
- effects of thymidine-incorporated, on cultured mammalian cells, lethal, 25:58086
- effects on isotopic exchange between ethane and hydrogen on nickel catalyst, 25:57428
- effects on radical addition of RSH to unsaturated compounds, 25:57426
- exchange with bound hydrogen in fluoroborate coolants, 25:57298 (ORNL-4676, pp 73-138)
- excretion and retention time in man following acute or chronic intake, method for calculation of, 25:57919
- handling of, storage as uranium tritide behind palladium diffusion tube for, 25:57502
- particle reactions at high energies, relativistic Feynman graphs in momentum representation for method for calculating amplitudes of, (T), 25:59528
- proton reactions (p,n) at 3 to 16 MeV, polarization transfer at 0° in, (E), 25:59695
- radioinduced production in irradiated mixed oxide fuels, relations with burnup, 25:58344(R) (LA-4693)
- separation from copper extracted from nuclearly fractured ores, method for, 25:57523 (ORNL-4677)
- separation from heavy water by isotope exchange with deuterium, 25:57545(P)
- separation from heavy water, design and operation of countercurrent distillation facility for, 25:57675
- triton reactions (t,nHe-4), determination of scattering length for n + n interactions at rest from, (E), 25:59506 (JINR-E15-5905)

TRITIUM SYSTEMS
- D--T, laser heating of plasma of, (T), 25:58965

TRITONS
- binding energy of, calculation using rank-four separable potential, (T), 25:59707
- binding energy of, separable potentials for, (T), 25:59517
- reactions (t,nHe-4) with tritium, determination of scattering length for n + n interactions at rest from, (E), 25:59506 (JINR-E15-5905)

TROPOSPHERE
- cyclones in upper, effects on Jan. 1964 fallout deposition on North America, 25:57572(R) (COO-1340-24)
- trough development at solar-activity maximum and minimum, relation with geomagnetic storms, (E), 25:58860

TSURUGA POWER REACTOR
- maintenance requirements for, 25:60191
- operation of, review of, 25:60191
- testing program for, 25:60191

TUBES
- defects in metal, standard ultrasonic method for detecting longitudinal, 25:57686
- inspection of electrically-conducting, eddy current method for, 25:57692(P)
- texture control in, effects of fabrication parameters on, 25:58186 (ORNL-TM-3500)

TUNGSTEN
- adhesion to (111) crystal surface of nickel, LEED study on, 25:58270
- compatibility with cobalt-59 fuels at 1200°C, 25:57654(R) (DP-1279)
- compatibility with platinum-base radioisotope fuel capsules at high temperatures, 25:57658(R) (ORNL-4723)
- crack nucleation and growth in powder metallurgy, electron fractography studies of, 25:58213 (ORNL-TM-3350)
- crystallization of foils of, structure of anomalously large grains in secondary re-, 25:58279
- deposition on plutonium oxide aging specimens, design of equipment for chemical vapor, 25:57658(R) (ORNL-4723)
- determination in pyrolytic graphite by neutron activation and counting of delayed β and γ coincidences, 25:57389
- effects of doping agent of, on radioinduced swelling of uranium carbide fuels, 25:58163(R) (AI-AEC-12859)
- effects on electric properties of lanthanum boride, temperature dependence of, 25:59183
- effects on electric properties of lanthanum hexaboride, 25:59182
- effects on hardness of dispersion-hardening iron-base alloys, 25:58235

XUM

electric conductivity at 1400 to 2100°C of wires of, temperature coefficient of, 25:58241
electric conductivity of laser-evaporated films of, temperature coefficient of, 25:59186
electron reactions at 12.5 to 22 MeV with, bremsstrahlung yield from, 25:59106
evaporation rate in strong electric fields, effects of nitrogen on, 25:58227
helium-ion reactions at 45 to 90 keV/amu with, helium-isotope dependence of cross sections for M-shell ionization in, (E), 25:58776
mechanical properties of single crystals of, effects of carbon on, 25:58257
neodymium desorption from filaments of, using electric field, 25:58230
performance of chemical vapor deposited capsules of, under stress at 1650°C, 25:57658(R) (ORNL-4723)
preparation by hydrogen reduction of tungsten trioxide, 25:58189
properties and uses of, newsletter on, 25:58206
proton scattering at high energy, analysis for recoil-nucleus effects in, (T), 25:59814
sintering of, parameters for activated, 25:58200
solubility in sodium hydroxide--sodium nitrate solutions, 25:58177
solvent properties for nitrogen at high temperatures, 25:58249
sorptive properties for oxygen on (100) surfaces of, at 20 to 1000°C, relations with work function, 25:58226
sorptive properties for residual gases in strong electric field, field-ion microscopic study of, 25:58246
sorptive properties of carbonized, for ytterbium, electron-emission study of, 25:58228
surface energy and work function of smooth faces of monocrystal of, (T), 25:59194
thermal cycling stability of, effects of rhenium on, 25:58247
thermionic performance of emitters of chloride vapor-deposited, with niobium and molybdenum collectors, 25:58839 (TEE-4125-5)
uses in Polish industry, economics of, 25:58164
vapor deposition on iron and nickel alloys, development of methods for chemical, 25:58168 (ORNL-4676, pp 139-233)
ytterbium desorption from filaments of, using electric field, 25:58230
zirconium deposition on single crystals of, field-emission microscopic study of surface structures from, 25:58229

TUNGSTEN ALLOYS AND SYSTEMS
properties and uses of, newsletter on, 25:58206
Al--Cr--Mo--W, development of cast, for turbine blades, 25:58203
Al--W, structure of drops of, formed at high cooling rates, 25:58284
C--Cr--Fe--Ni--Si--W, metallography of carbide structures in cast heat-resistant, 25:58399
Co--Fe-base--W, hardness of dispersion-hardening hard facing, effects of primary and secondary additions on, 25:58235
Cr--W, uses for milling surface-hardened specimen by hard-facing process, 25:58196
Cu--W, crystallization of electron beam-refined composites of, 25:58285
H--W, heat transfer by aerosols of, measurement by extinction parameters at high temperatures, 25:57641
Hf--Pt-base--Rh--Ti--W, hardness of crystallized, effects of annealing at high temperatures on, 25:57658(R) (ORNL-4723)
Mo--W, solvent properties for nitrogen at high temperatures, 25:58249
Mo-base--W, mechanical properties and recrystallization temperature of, effects of tungsten content on, 25:58248
Mo-base--W--Zr, mechanical properties and recrystallization temperature of, effects of tungsten and zirconium contents on, 25:58248
Nb--W, composition of electronic-melted zone liquation-produced, 25:58260
Ni--W, hardness of electrolytically deposited, relations of internal stresses with micro-, 25:58236
Pt-base--Rh--W, compatibility with tungsten at high temperatures, 25:57658(R) (ORNL-4723)
Pt-base--Rh--W, hardness of crystallized, effects of annealing at high temperature on, 25:57658(R) (ORNL-4723)
Re--W-base, compatibility with cobalt-59 fuels at 1200 to 1400°C, 25:57654(R) (DP-1279)
Re--W-base, creep rupture of deformed powder metallurgy, at 500 psi, mechanisms of, 25:58213 (ORNL-TM-3350)
Ta-base--W, mechanical properties at high temperatures, effects of oxygen doping on, 25:57658(R) (ORNL-4723)
ThO$_2$--W-base, particle morphology in, effects of deformation on, 25:58264

TUNGSTEN CARBIDES
crystal structure of systems of, electron microscopy and optical studies on relation of physical properties to, 25:58403
physicochemical properties of, effects of ionic heating during diffusion welding on surface, 25:58233
preparation of nonporous, by hot isostatic pressing, 25:58197
properties and uses of, newsletter on, 25:58206
solubility in sodium hydroxide--sodium nitrate solutions, 25:58177
use in production of hard metals, 25:58261
Co--WC, dynamic behavior of cemented, effects of defects on, (T), 25:58380
Co--WC, production and properties of, 25:58261
Co--WC, solubility in sodium hydroxide--sodium nitrate solutions, 25:58177

TUNGSTEN ISOTOPES W-181
content in off-site vegetation following Schooner Event, (E), 25:57574 (PNE-524)

TUNGSTEN ISOTOPES W-186
neutron reactions (n,2n) at 14.8 MeV, cross sections and gamma spectra from, (E), 25:59797

TUNGSTEN ISOTOPES W-187
content in off-site atmosphere, milk, and water supplies following Schooner event, (E), 25:57574 (PNE-524)
content of cows' milk following ingestion of hay contaminated with Plowshare debris, 25:57948 (SWRHL-85-r)

TUNGSTEN ORES
processing of, newsletter on, 25:58206

TUNGSTEN OXIDES
adhesion to (111) crystal surface of nickel, LEED study on, 25:58270
analysis for trace amounts of metals, effects of halide additives on direct spectrographic, 25:57335
preparation of thin-film targets of, using Zapon temporary backing, 25:59639 (CONF-711002-, pp 134-43)
proton and helium-ion scattering at 275 keV from amorphous, spectra of low-angle, (E/T), 25:58689
reduction to metal using hydrogen, effects of water vapor on, 25:58189
PuO$_2$--UO$_2$--WO$_3$, reduction to tungsten-modified carbide fuels, carbothermic, 25:58365 (AI-AEC-12983)

TURBINE BLADES
wear in, radioistope tracers method for measuring, 25:57663

TURBINES
design of direct cycle helium, for power reactors, 25:60145
flow control system for gas, description of, 25:60073(P)
thermal expansion of components in, use of radioisotope tracers for measuring, 25:57663

TURKEY POINT POWER REACTOR, UNIT 3
construction of, request for not suspending permit for, 25:59948 (DOCKET-50250-50)

TURKEY POINT POWER REACTOR, UNIT 4
construction of, request for not suspending permit for, 25:59948 (DOCKET-50250-50)

TZM (MOLYBDENUM ALLOY)
radiation effects on regular void array in high-purity, high-temperature 2-MeV nitrogen ion, 25:58340

U

UDIMET 700
etching by selective cavitation, method for, 25:58190

ULTRASONIC TESTING
method for detecting longitudinal defects in metal pipes and tubing, standard for, 25:57686
method for inspecting clad and plain steel plates, standard for straight-beam, 25:57695
method for inspecting welds, standard for contact, 25:57685
method for welded joints in reactors, 25:57680 (ORNL-TM-3561)

ULTRASOUND
effectiveness for diagnosis of tumors in human liver, 25:58044
effects on microflora of wine, additive effects of uv radiation on, 25:58158

ULTRAVIOLET ASTRONOMY
frequency range in, (E), 25:58445

ULTRAVIOLET RADIATION
absorption by nerve fibers, effects of wavelength on, 25:57942
effects on bacteriophages, protective effects of versene against, 25:58032
effects on chemical properties and ultrastructure of pigeon erythrocytes in vitro, effects of dose on, 25:58113
effects on cultured human cells following microbeam exposure of cytoplasm or nucleus, lethal, 25:58084
effects on dilute sulfuric acid solutions of gadolinium, terbium, or uranium, formation of hydrates of peroxides from, 25:57416
effects on distribution of nucleotides to photoproduct in excised fragments from Escherichia coli DNA, 25:57928
effects on DNA of Escherichia coli, enzymatic repair of, 25:57928
effects on DNA of mammalian cells, review of repair mechanisms for, 25:57943
effects on DNA of Micrococcus luteus, role of endonuclease and exonuclease in repair of, 25:57935
effects on DNA synthesis in Chlamydomonas, dark repair of, 25:57925
effects on DNA synthesis in polytene chromosomes of Drosophila, 25:57951 (COO-1747-6)

XUM

  effects on electrophysiological activity of nerve fibers, molecular basis of, 25:57942
  effects on Escherichia coli, effects of 5-bromouracil substitution of DNA on mutagenic, 25:57965
  effects on F-prime sex factors in Escherichia coli, induction of prophage lambda through conjugal transfer of, 25:57956
  effects on genetic repair and synthesis of nitrate reductase in Ustilago, 25:57955
  effects on growth and mitotic index of HeLa cells, effects of 5-fluorouracil on, 25:58082
  effects on isolated nerve fibers of crab, studies on role of nucleotides in excitability characteristics using, 25:57939
  effects on microflora of wine, additive effects of ultrasound on, 25:58158
  effects on Neurospora, effects of diepoxybutane on photoreactivation of mutagenic, 25:57954
  effects on silica and germania, ESR studies of defects induced in, 25:59174
  effects on single crystals or ammonium dioxovanadium(V) bisoxaltate dihydrate, ESR studies on vanadyl ions produced by, 25:57449
  effects on survival of KB cells, effects of cyclic AMP and hydrocortisone on, 25:58087
  effects on yeast, studies on genetic control of mutagenic, 25:57976
  emission from stars, (E), 25:58445
  heating of gases by, optical line spectra due to, (T), 25:58629
  interaction of solar extreme-, with interstellar hydrogen, effect on interstellar magnetic-field location, (T), 25:58631
  interpretation for cosmic background far-, (T), 25:58638
UNITED KINGDOM
  electric power production in, forecasts to year 2000, 25:57633
  radioisotope shipping through ports in, standards for safe, 25:57711
UNITED STATES
  fallout monitoring during 1970, 25:57980(R) (HASL-245)
  radioisotope content of drinking and surface waters during 1970, radium-226, strontium-90, and tritium, 25:57991
UNIVERSE
  dissipative processes in early, (T), 25:58669
  matter in, extreme regimes of pressure and temperature of, (T), 25:58520
URACIL
  radiolysis of aqueous solutions of, products from electron pulse, 25:57930
URACIL, 5-BROMO-
  effects on uv-radiosensitivity of Escherichia coli, 25:57965
URACIL, 5-FLUORO-
  effectiveness for treatment of radiodermatitis of man, 25:58037
  effects on growth and mitotic index of uv irradiated HeLa cells, 25:58082
  effects on uv radiosensitivity of HeLa cells, 25:58082
URANIUM
  abundance on surfaces of peculiar A stars, (E/T), 25:58462
  abundance variations in ocean sediments, 25:57588
  bonding aluminum fins to fuel tubes of, method for diffusion, 25:58207
  burnup in fast reactor fuels, effects of fuel cycle on, (T), 25:60095(R) (IAEA-R-742-F)
  complexes with p-hydroxybenzoic acid and phenylacetic acid, stability of, 25:57402
  compounds, dissolution in organic extraction reagents saturated with mineral acids, 25:57547
  compounds, preparation of π-allyl, 25:57408(P)
  content in manganese nodules, α-particle and induced fission track methods for measuring, 25:57570
  content in volcanic obsidian, geologic origin of, 25:57569
  deposition as oxide on instrument parts of stainless steel, electrolytic, 25:57440
  desorption and recrystallization in rocks during metamorphism, 25:57581
  determination in high-purity silicon dioxide by luminescence method, 25:57328
  determination in mixed oxide fuels, development of methods for, 25:58344(R) (LA-4693)
  determination in monazite sands by solvent extraction and polarography, 25:57334
  determination in presence of iron as carbonate complex, polarographic, 25:57321
  determination in rare earth oxides by TBP extraction and photometry, 25:57341
  determination in silicate rocks by neutron activation, low-energy photon detector for, 25:57387
  determination in thorium dioxide--uranium dioxide fuels by controlled potential coulometry, 25:57305
  determination in washing, processing, and waste waters by spectrophotometry, 25:57343
  determination of natural, in urine, methods used at CNEN for, 25:57347 (RT/PRCT-(71)9)
  determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
  determination relative to plutonium in oxide fuels during fabrication, 25:57507(R) (ANL-7799)
  distribution as uranyl ion between solutions and carbonate precipitates, 25:57409
  distribution between marine calcareous skeletons and seawater, 25:57409
  distribution in granites from Central Kazakhstan, statistical analysis of, 25:57583
  effects on complexonometric determination of rare earths, 25:57317
  effects on spectrophotometric determination of calcium, 25:57304
  enrichment technology for, effects on development of nuclear power plants in Japan, 25:59904
  geochemistry in Gulf of Mexico, 25:57587
  oxidation potential for trivalent--tetravalent, 25:57437
  photochemistry of dilute sulfuric acid solutions of, formation of hydrates of peroxides in, 25:57416
  photon reactions with, secondary electron emission from, (E/T), 25:59107
  plasma of, spectroscopic diagnostics of, 25:59000
  preparation of radiation targets of, by argon ion sputtering, 25:59637 (CONF-711002-, pp 109-15)
  preparation of radiation targets of, methods for, 25:59634 (CONF-711002-, pp 59-69)
  preparation of standard thin-film layers of, by vacuum evaporation, 25:58182 (CONF-711002-, pp 122-33)
  preparation of thick samples of, by powder metallurgy, 25:58181 (CONF-711002-, pp 77-81)
  preparation of thin films of, by electrophoresis and electrospraying, 25:58183 (CONF-711002-, pp 160-5)
  production and uses of, review on factors affecting, 25:58191
  production by underground leaching of ores and treatment in ion exchange column, 25:57536
  purification of, obtained from reprocessing of thorium reactor fuel by Thorex two-stage process, 25:57541
  separation as uranyl from nitric acid solutions by solvent extraction using TBP, 25:57557
  separation from fast breeder fuels by Purex Process solvent extraction, 25:57518(T) (EURFNR-888)
  separation from fission products, properties of styrene--divinylbenzene polymers for chromatographic, 25:57527 (UJV-2557-Ch)
  separation from irradiated fuels in reprocessing of reactor fuels by solvent extraction method, 25:57534(P)
  separation from MSBR fuel by fluoride volatility process, flowsheet analysis for, 25:57522 (ORNL-4676, pp 234-71)
  separation from MSBR fuel by oxide precipitation, 25:57522 (ORNL-4676, pp 234-71)
  separation from other actinides by paper or thin-layer chromatography, 25:57553
  separation from overhead product from reprocessing of Rover Rocket fuels by burn-leach process, 25:57519 (IN-1484)
  separation from plutonium by solvent extraction using TBP, 25:57357
  separation from rare earths and thorium by solvent extraction using TBP, 25:57341
  separation from seawater by adsorption using titanic acid, 25:57337
  separation from sulfuric acid solutions by ion exchange, evaluation of fluoropolymer anion exchange materials for, 25:57555
  separation from thorium by ion exchange, 25:57342
  separation from thorium reactor fuel with high burnup by Thorex two-stage process, 25:57541
  separation from various compounds without preliminary dissolution in acid by solvent extraction, 25:57547
  toxic effects on rabbits and rats, additive effects of mercuric bichloride on, 25:58099
URANIUM ACETATES
  uranium-238 neutron capture in, chemical states of recoil uranium-239 from, 25:57488
URANIUM ALLOYS AND SYSTEMS
  preparation of reference specimens of, methods for, 25:58179 (CONF-711002-, pp 47-58)
  Al--U-235, criticality parameters of hollow cylinders in water, (E/T), 25:60212
  Bi--U, magnetic transition temperature of U_3Bi_4, 25:59190
  Ga--U, magnetic transition temperature of UGa_2, 25:59190
  Hf--U, liquidus and solidus curves for, calculations for, 25:58292
  O--Pu--U, phase studies of, 25:58409
  Th-base--U, fabrication of fuel elements of, for unclad metal breeder reactor, 25:58185 (ORNL-TM-3499)
  U--Zr, liquidus and solidus curves for, calculations for, 25:58292
URANIUM CARBIDES
  chlorination of, thermogravimetric study of, 25:57542
  radiation effects on fuels of, helium ion, 25:58163(R) (AI-AEC-12859)
  radioinduced swelling of niobium-clad fuels of, effects of tungsten doping on in-pile, 25:58163(R) (AI-AEC-12859)
  PuC--UC, hardness of fuels of, at 400 to 500°C, 25:58344(R) (LA-4693)
  PuC--UC, phase studies of, 25:58344(R) (LA-4693)

XUM

- PuC--UC, preparation of fuels of, method for, 25:58163(R) (AI-AEC-12859)
- PuC--UC, preparation of tungsten-modified, by carbothermic reduction of mixed component oxides, 25:58365 (AI-AEC-12983)
- PuC--UC, radiation effects on encapsulated fuels of, at high burnups, in-pile, 25:58344(R) (LA-4693)

URANIUM CHLORIDES UCl_4
- magnetic susceptibility of anhydrous, 25:57419
- preparation of anhydrous, by reaction of uranium dioxide with carbon tetrachloride vapor, 25:57419

URANIUM DEPOSITS
- description and occurrence of, in sedimentary rocks, 25:57584
- prospecting for, pulsed neutron well logging method for, 25:57560 (INP-732)

URANIUM FLUORIDES UF_4
- enthalpy at 298 to 1400°K, 25:57298 (ORNL-4676, pp 73-138)
- BeF_2--LiF--ThF_4--UF_4, heat transfer and thermophysical properties of, (E/T), 25:60015 (ORNL-4676, pp 21-72)
- TlF--UF_4, crystal structure of phases in, differential thermal analysis and x-ray crystallography studies on, 25:58418

URANIUM FLUORIDES UF_5
- disproportionation equilibrium of solutions of, 25:57298 (ORNL-4676, pp 73-138)

URANIUM FLUORIDES UF_6
- enrichment by chemical exchange, distillation, or exchange chromatography, 25:57528 (UR-3999-11)

URANIUM ISOTOPES
- cross section measurements of, nondestructive and destructive methods of analysis used in fabrication of targets for, 25:57345 (CONF-711002-, pp 293-306)

URANIUM ISOTOPES U-230
- energy levels from protactinium-230 beta decay, spin--parity assignments for, (E), 25:59800
- energy-level transitions from protactinium-230 beta decay, branching ratios and multipolarities for, (E), 25:59800

URANIUM ISOTOPES U-232
- energy levels from protactinium-232 beta decay, spin-parity assignments for, (E), 25:59798
- energy-level transitions from protactinium-232 beta decay, branching and mixing ratios, internal conversion coefficients, and multipolarities for, (E), 25:59798
- production by neutron irradiation of thorium-230 and thorium-232 mixtures, 25:57479 (EMBW-FBK-71-6)

URANIUM ISOTOPES U-233
- excretion and retention time in man following acute or chronic intake, method for calculation of, 25:57919
- neutron fission at thermal to 2 MeV energies, energy dependence of prompt neutron yield from, (E), 25:59810
- preparation of aluminum-clad foils of, method for, 25:58180 (CONF-711002-, pp 70-6)

URANIUM ISOTOPES U-234
- content ratio to thorium-230 in East Pacific Rise sediments and iron deposits, 25:57585
- content ratio to uranium-238 in East Pacific Rise sediments and iron deposits, 25:57585
- excretion and retention time in man following acute or chronic intake, method for calculation of, 25:57919

URANIUM ISOTOPES U-235
- concentration in uranium hexafluoride by chemical exchange, distillation, or exchange chromatography, 25:57528 (UR-3999-11)
- critical mass of spherical assemblies of mixed natural uranium and, with water reflector and moderator, (T), 25:60220
- determination in urine, methods used at CNEN for, 25:57347 (RT/PROT-(71)9)
- neutron fission at thermal to 2 MeV energies, energy dependence of prompt neutron yield from, (E), 25:59810
- neutron fission of, production and study of bromine delayed neutron precursors from, 25:57504
- neutron scattering cross sections for, multilevel analysis of data for, (T), 25:59828 (COO-2022-10)
- photofission at 0.1 to 5 GeV, giant resonance and 300-MeV resonance in yields and integral cross sections for, (E), 25:59794
- preparation of aluminum-clad foils of, method for, 25:58180 (CONF-711002-, pp 70-6)
- separation from uranium-238 by chemical exchange, distillation, or exchange chromatography as uranium hexafluoride, 25:57528 (UR-3999-11)

URANIUM ISOTOPES U-236
- fission of, prompt neutron yield and half-life for spontaneous, (E), 25:59806
- neutron fission at 0.8 to 6.7 MeV, energy dependence of prompt neutron yield from, (E), 25:59806

URANIUM ISOTOPES U-238
- content ratio to uranium-234 in East Pacific Rise sediments and iron deposits, 25:57585
- fission of, prompt neutron yield and half-life for spontaneous, (E), 25:59806
- neutron capture at 400 keV, compound-nucleus-model analysis of cross sections and gamma spectra from, (E/T), 25:59801
- neutron fission of, evaluation of average neutron yield from, 25:59775 (AWRE-O-44/71)
- photofission at 0.1 to 5 GeV, giant resonance and 300-MeV resonance in yields and integral cross sections for, (E), 25:59794
- preparation of aluminum-clad foils of, method for, 25:58180 (CONF-711002-, pp 70-6)
- separation from uranium-235 by chemical exchange, distillation, or exchange chromatography as uranium hexafluoride, 25:57528 (UR-3999-11)

URANIUM ISOTOPES U-239
- chemical states of recoil, from neutron capture by uranium-238 in uranium and uranyl acetates and sulfates, 25:57488

URANIUM MINERALS
- oxidation in uranium mines, use of bacterial activity for increasing, 25:57582

URANIUM NITRIDES
- magnetic specific heat and spin disorder resistivity of UN, (T), 25:59180

URANIUM ORES
- leaching of, research on improving efficiency of underground, 25:57536
- mining of, contribution of oxidizing bacterial activity to, 25:57582

URANIUM OXIDES
- dissolution in organic extraction reagents saturated with mineral acids, 25:57547
- effects on in vitro phagocytic response of cells from rat lungs, 25:57923

URANIUM OXIDES UO_2
- analysis for trace amounts of silicon by spectrophotometry using molybdenum blue method, 25:57340
- compaction of sol-gel powders of, performance of pneumatic vibrators in, 25:58364
- electric conductivity and thermoelectric power of superstoichiometric, at high temperatures, 25:59191
- electric conductivity of sintered, effects of grain size on, 25:59184
- etching of, mechanism studies on, 25:58244
- fission product retention by fuel particles of, effects of aluminum oxide and niobium oxide doping on, 25:58347 (JUL-730-RW)
- grain growth in sintered, effects of pore gas pressure at 1650 to 1850°C on, 25:58408
- mechanical properties of sintered powders of, at 25°C, relations with density, 25:58389(R) (SRO-552-8)
- microstructure of sintered powders of, effects of initial particle size on, 25:58389(R) (SRO-552-8)
- oxidation and dissolution in tributyl phosphate solutions saturated with nitric acid, 25:57548
- polishing of, method for attack, 25:58353
- preparation from uranyl nitrate, fluid-bed process for, 25:57507(R) (ANL-7799)
- preparation of aluminum oxide- and niobium oxide-doped fuel particles of, method for, 25:58347 (JUL-730-RW)
- preparation of thin irradiation samples of, abrasive blasting method for, 25:58411(R) (GEAP-12217)
- preparation of thin irradiation specimens of, ion milling method for, 25:58411(R) (GEAP-12217)
- radiation effects on elongation and pellet-clad interactions in fuel pins of, in-pile, 25:58414
- rare gas behavior in, review of stages of, 25:58413
- reactions with carbon tetrachloride vapor, preparation of anhydrous uranium tetrachloride by, 25:57419
- shipping of irradiated SPERT III fuels of, design of container for, 25:57703 (DPSPU-71-124-4A)
- stoichiometry in thorium dioxide--uranium dioxide fuels, coulometric studies on, 25:57305
- storage behavior of sintered, effects of grain boundaries, specific surface, and time on, 25:58371
- thermal conductivity of sintered powders of, effects of porosity on, 25:58389(R) (SRO-552-8)
- Mo--UO_2-base, preparation of dense homogeneous, method for, 25:58348 (LFEN-NI.-53-a)
- Nb--UO_2-base, preparation of dense homogeneous, method for, 25:58348 (LFEN-NI.-53-a)
- PuO_2--UO_2, analysis of fuels of, for plutonium and uranium, methods for, 25:58344(R) (LA-4693)
- PuO_2--UO_2, melting heat rating of, (E), 25:60243
- PuO_2--UO_2, microstructure of fuel pellets of, for fast flux irradiation studies, 25:58397
- PuO_2--UO_2, plutonium segregation in, neutron radiographic method for detection of, 25:57698
- PuO_2--UO_2, preparation of fuels from reprocessed, CNEN and SNAM methods for, 25:58351 (RT/ING-(70)30)
- PuO_2--UO_2, properties of stainless steel-clad fuel pins of, for 1000 MW(e) helium-cooled breeder reactor, mechanical and thermal, 25:58410 (BLG-456)
- PuO_2--UO_2, radiation effects on enthalpy of fuels of, in-pile, 25:58344(R) (LA-4693)
- PuO_2--UO_2, radioautography of irradiated fuel elements of, method for hot cell, 25:57693
- PuO_2--UO_2, radioinduced tritium production in, relations of burnup with fast neutron, 25:58344(R) (LA-4693)
- PuO_2--UO_2--WO_3, reduction to tungsten-modified carbide fuels, carbothermic, 25:58365 (AI-AEC-12983)
- ThO_2--UO_2, analysis for uranium and uranium dioxide stoichiometry, coulometric, 25:57305

URANIUM OXIDES UO_3
- production of highly enriched, by fluidized-bed denitration of uranyl nitrate at ICPP, 25:57397 (IN-1475)
- reactions of amorphous, with carbon monoxide, 25:57417

URANIUM OXIDES U_3O_8
  preparation of targets of, by vacuum evaporation, 25:59638 (CONF-711002-, pp 116-21)
URANIUM PHOSPHIDES
  magnetization of UP, anomalous temperature dependence of, (E/T), 25:59189
URANIUM SILICIDES
  polishing of, method for attack, 25:58353
  radioinduced swelling of U_3Si, 25:58209 (AECL-3992)
URANIUM SULFATES
  uranium-238 neutron capture in, chemical states of recoil uranium-239 from, 25:57488
URANYL ACETATES
  uranium-238 neutron capture in, chemical states of recoil uranium-239 from, 25:57488
URANYL CARBONATES
  complex ion distribution in aqueous solutions of, 25:57398 (NIM-1093)
  UO_2CO_3--UO_2SO_4, equilibrium distribution and solubility diagrams for aqueous solutions of, 25:57399 (NIM-1144)
URANYL CHLORIDES
  complexes with tetrakis(decyl)ammonium chloride, reactions with titanium chloride for reduction of uranyl ion, 25:57415
URANYL IONS
  reactions with silicic acid in aqueous solution, spectrophotometric study of, 25:57406
  symmetry of excited states of, in uranyl nitrate crystals, 25:58703
URANYL NITRATES
  denitration of enriched, ICPP fluidized-bed process for, 25:57397 (IN-1475)
  symmetry of excited states in crystals of, 25:58703
  $Pu(NO_3)_4$--$UO_2(NO_3)_2$, processing at West Valley Processing Plant, safety evaluations for, 25:57514 (DOCKET-50201-89)
URANYL SULFATES
  effects on nitrification by Nitrobacter agilis in soil suspension, 25:57401
  uranium-238 neutron capture in, chemical states of recoil uranium-239 from, 25:57488
  $Fe_2(SO_4)_3$--UO_2SO_4, complex ion distribution in aqueous solutions of, 25:57398 (NIM-1093)
  UO_2CO_3--UO_2SO_4, equilibrium distribution and solubility diagrams for aqueous solutions of, 25:57399 (NIM-1144)
UREA
  radioprotective effects against chlorophyll mutations in barley, x, 25:57974
UREA, SELENO-
  radiosensitizing effects of, on Escherichia coli, effects of anoxia on x, 25:58155
UREA, THIO-
  effects on γ and x radioinduced mutations in bacteriophage phi X174, 25:57971
  radioprotective effects against chlorophyll mutations in barley, x, 25:57974
URINE
  analysis for α, β, and γ emitters, methods used at CNEN, 25:57347 (RT/PROT-(71)9)
  analysis for cesium-137 by radiochemical isolation and γ spectrometry or beta detection, 25:57355
UTERUS
  radiotherapy of cervical carcinomas of, effectiveness of intracavitary radium, super-high voltage x, and telecobalt γ, 25:58070
  radiotherapy of remnants of cervical tumors of human, following external γ or x radiotherapy, effectiveness of small radiation sources for, 25:58074

V

VAGINA
  radioinduced lesions of human, following therapy of gynecologic neoplasms, 25:58135
VALVES
  design characteristics of ball closure system, for coolant flow control in power reactor fuel channels, 25:60072(P)
  design of safety, for BWR-type power plants, 25:57637
  stability of MSRE FV105, evaluation of, 25:58168 (ORNL-4676, pp 139-233)
VAN ALLEN RADIATION BELTS
  boundary of, higher-rigidity particle occurrence at lower latitudes of, (E/T), 25:58907
  parameters of, relation to solar-wind, magnetic activity, and magnetotail electron-flux parameters, (E/T), 25:58852(T) (LA-tr-71-69)
  particle event of March 1970 in, observation of solar, (E), 25:58892
  plasma instabilities in, review of, 25:58895
  proton intensity in, satellite measurements of 0.25- to 1.65-MeV, (E), 25:58890
  zone above, existence of unstable, (E/T), 25:58906
VAN DE GRAAFF ACCELERATORS
  beam energy control and monitoring system for FN tandem, circuit design and performance for, 25:59653
VANADIUM
  activity in titanium--vanadium alloys, effects of hydrogenation on, 25:58220
  content of foods in Kiev region of Soviet Union, 25:57987
  determination in ferrovanadium and iron ore following ion exchange chromatographic separation, potentiometric, 25:57339
  determination of trace amounts of, in tungsten trioxide or zirconium dioxide, effects of halide additives on direct spectrographic, 25:57335
  effects on recovery of aluminum irradiated with fast neutrons, 25:58303
  production of monocrystalline high-purity, by zone melting, 25:58192
  radioinduced void formation in, electron microscopic study of fast neutron, 25:58309
  radioinduced void formation in, neutron, 25:58300 (ORNL-TM-3496)
  solvent properties for nitrogen at high temperatures, 25:58249
VANADIUM ALLOYS AND SYSTEMS
  preparation of reference specimens of, methods for, 25:58179 (CONF-711002-, pp 47-58)
  Al--Sn--Ti-base--V, heat treatment of, using molten glass, 25:58199
  Al--Ti-base--V, bonding of, method for diffusion, 25:58207
  Al--Ti-base--V, drawing of, testing of lubricants for deep, 25:58195
  Al--Ti-base--V, extrusion of thin-walled tubes of, development of method for, 25:58199
  Al--Ti-base--V, rolling of sheets of, development of method for, 25:58199
  Co--V, structural transformations in molten, relations of vacancy mechanisms with eutectic--peritectic, 25:58281
  Cr--Ti--V-base, radiation effects on tensile properties of, alpha particle, 25:58163(R) (AI-AEC-12859)
  Fe--Ni--V, electric, magnetic, and mechanical properties of $Ni_3(Fe,V)$ solid solutions, 25:59188
  Fe--V, analysis for vanadium following ion exchange chromatographic separation, potentiometric, 25:57339
  Ga--V--Y, phase studies of, 25:58289
  H--V, hydride precipitation in, electron microscopy studies on, 25:58407
  Ni--V, oxidation in air at 1000°C, activation energy for, 25:58251
  O--Sc--V, phase studies at 1000 to 1500°C, 25:58401
  Ti--V, phase formation in, effects of temperature on omega, 25:58283
  Ti--V, radiation effects on deformation in, low-temperature neutron, 25:58339
  Ti--V, vanadium activity in, effects of hydrogenation on, 25:58220
  Ti--V-base, radiation effects on tensile properties of, alpha particle, 25:58163(R) (AI-AEC-12859)
  Ti--V-base, radioinduced void formation in, electron microscopic study of fast neutron, 25:58309
  Ti--V-base, radioinduced void formation in, neutron, 25:58300 (ORNL-TM-3496)
  V--VO, phase diagram of, proposed, 25:58406
  V--Zr-base, properties of dilute cast, electric and mechanical, 25:58258
VANADIUM ISOTOPES V-46
  energy levels from titanium-46 (He-3,t) reactions, spin assignments for, (E), 25:57901
VANADIUM ISOTOPES V-47
  energy levels from titanium-46 (p,γ) reactions, isobaric analog, (E), 25:59752
VANADIUM ISOTOPES V-48
  beta decay of, β--γ circular polarization correlations and Coulomb and Fermi matrix elements in, (E), 25:59746
VANADIUM ISOTOPES V-51
  helium-3 elastic scattering at 29 to 35 MeV, optical-model analysis of differential cross sections for, (E), 25:59769
VANADIUM OXIDES
  crystal growth of V/sub n/O/sub 2n-1/ single crystals for 3 less than or equal to n less than or equal to 8, 25:58369
  crystal structures of V/sub n/O/sub 2n-1/ single crystals for 3 less than or equal to n less than or equal to 8, 25:58393
  diffusion of oxygen through V_2O_5 layers, effects of electric field on, 25:58383
  electric properties of V/sub n/O/sub 2n-1/ for 3 less than or equal to n less than or equal to 8, 25:58369
  properties of V_2O_3 as electrode material for liquid iron, 25:57441
  structure of γ-$VO_{0.5}$, 25:58392
  V--VO, phase diagram of, proposed, 25:58406
VANADYL IONS
  radioinduced in single crystals of ammonium dioxovanadium(V) bisoxalate dihydrate, ESR studdies on uv or x, 25:57449
VEGETABLES
  lettuce, harvesting of head, gamma radiometric densimeter for selective, 25:57871(P)
  potatoes, radiation processing for inhibition of sprouting during storage, public health hazards from γ, 25:58159
VEHICLES
  design and operation of motor, for monitoring and decontaminating objects and persons, 25:57622(P)

XUM

VELA PROJECT
rocks near Project Dribble site in, sonic velocity of sedimentary, (E), 25:57595 (USGS-474-112)
site of Dribble Project in, core and logging data on Hydrologic Test Well 1 at, 25:57562 (USGS-474-110)
site of Dribble Project in, core and logging data on Hydrologic Test Well 2 at, 25:57563 (USGS-474-111)
site of Project Dribble in, stratigraphy of, 25:57596 (USGS-474-129)
VERMONT YANKEE POWER REACTOR
startup of, effects on regional power supply of delay in, 25:59956 (DOCKET-50271-63)
VESSELS
regulations for hazardous materials shipping, Dept. of Transportation, 25:57710
seals for rotatable covers of liquid metal cooled reactor core, 25:60021(P)
VIBRATIONS
analysis of torsional, computer program for, 25:60057 (AECL-3994)
effects of low frequency, on Drosophila, 25:57953
VINYL ALCOHOL POLYMERS
radioinduced disorientation of, gamma, 25:58417
VIRIAL COEFFICIENTS
relation of second, to S matrix, new derivation of, 25:59220
VIRUSES
effects on initiation of human umbilical cord leukocyte cell cultures, 25:57921
polyoma, effects on ultrastructure of cells in thymus gland of mice, 25:58114
VITAMIN A GROUP
radioprotective effects against ulceration in rabbit skin, x, 25:58036
VK-50 REACTOR
hydrodynamics of, design problems for, 25:60065

W

WATER
analysis for gold, selenium, and tellurium by neutron activation, 25:57370
analysis for iron-59 by polarography or scintillation γ spectrometry, 25:57346 (IFA-FR-82)
analysis for mercury by neutron activation and radiochemical separation, 25:57392
analysis for trace elements by neutron activation and γ spectrometry, 25:57395
analysis for uranium, spectrophotometric, 25:57343
analysis of JRR-1 coolant, for aluminum, 25:57320
analysis of reactor effluent, for radioisotopes, ion-exchange sampler for use in, 25:57351
boiling of subcooled, during free convection quenching of spheres, heat transfer for film and transition, (E), 25:57642
concentration device for radioactive waste, continuous, 25:57900(P)
electron reactions at 60 eV with, production of excited oxygen ions (O^+) in, (E), 25:58763
heat transfer crisis in boiling, flowing through fuel rod bundles, 25:57638 (IAE-2014)
neutron inelastic scattering at 0.04 to 0.632 eV at 27 to 270 C, differential cross sections for, (E/T), 25:59685
neutron reactions at 14 MeV, fast neutron spectra from pulsed, 25:59674
purification of water cooled reactor primary, analysis of distillation methods for, 25:60064
radiolysis of, effects of thallium sulfate on yields of hydrogen and hydrogen peroxide from γ, 25:57472
use in cooling casks and waste containers, 25:57706 (ORNL-TM-3545)
vibration spectra of, pulsed neutron-scattering of, 25:58384
air--H_2O, flow in vertical channels, gamma attenuation method for measuring void fraction in, 25:57648
Ar--H_2O, radiolysis of, charge exchange and transition reactions of hydrogen from electron, 25:57460
WATER-d_2
neutron scattering cross section for, computer code using Butler model for thermal, 25:59689
neutron scattering in, computer program for double differential cross sections, scattering matrix, and integrated cross sections for, (T), 25:59671 (IFA-DNBR-3)
production of, bibliography on industrial facilities and processes for, 25:57652 (DAISE-70-8)
purification from hydrogen and tritium by isotope exchange with deuterium gas, 25:57545(P)
separation of stable oxygen isotopes from, design and operation of columns for countercurrent, 25:57675
WATER-t
determination of, evaluation of 5 scintillators for use in, 25:57363
toxicity to different species of animals, comparison of, 25:57916
WATER-t_2
determination of, evaluation of 5 scintillators for use in, 25:57363
toxicity to different species of animals, comparison of, 25:57916
WATER SUPPLIES
fallout monitoring during 1970, 25:57980(R) (HASL-245)
radioisotope content of New York City, during 1970, cesium-137 and strontium-90, 25:57981(R) (HASL-245(App.))
radioisotope content of USA, during 1970, radium-226, strontium-90, and tritium, 25:57991
tritium content of off-site, following Schooner Event, (E), 25:57574 (PNE-524)
tungsten-187 content of off-site, following Schooner Event, (E), 25:57574 (PNE-524)
WATER VAPOR
effects on hydrogen reduction reactions with molybdenum trioxide and tungsten trioxide, 25:58189
electron reactions with, K--LL Auger spectra from, (E), 25:58736
WATERFORD POWER REACTOR, UNIT 3
design parameters of, revised and additional data on, 25:59996 (DOCKET-50382-11)
operations aspects of, revised and additional data on, 25:59996 (DOCKET-50382-11)
WATERFORD POWER REACTOR, UNIT 4
construction of, withdrawal of permit application for, 25:59997 (DOCKET-50382-12)
design parameters of, revised and additional data on, 25:59996 (DOCKET-50382-11)
operation of, withdrawal of license application for, 25:59997 (DOCKET-50382-12)
operations aspects of, revised and additional data on, 25:59996 (DOCKET-50382-11)
WEAR
control of railroad track, use of radioisotopes for, 25:57672
measurement of turbine blade, using radioisotope tracers, 25:57663
WEISWEILER POWER REACTOR
design parameters of, 25:60012 (JUL-775-RG)
physics measurements for, 25:60012 (JUL-775-RG)
WELDED JOINTS
inspection of reactor, methods for remote nondestructive, 25:57680 (ORNL-TM-3561)
WELDING
methods for fabrication of Grosswelzheim Superheat Reactor fuel elements, review on, 25:58205
methods for zirconium and zirconium alloy fuel cladding, description of electron beam and tungsten inert gas, 25:58188 (ZJE-110)
WELDS
inspection of metal, standard ultrasonic contact method for, 25:57685
inspection of thick, betatron radiography method for, 25:57678 (INR-1204)
WELL LOGGING
equipment for simultaneous electric resistivity and radioactive, design of, 25:57571(P)
method of pulsed neutron, for uranium prospecting, 25:57560 (INP-732)
WEST VALLEY PROCESSING PLANT
radioactive waste processing facility at, technical specifications for low-level, 25:57512 (DOCKET-50201-87)
safety analysis for, role of tornado missiles in, 25:57513 (DOCKET-50201-88)
safety evaluation for plutonium nitrate--uranyl nitrate transfer and processing in, 25:57514 (DOCKET-50201-89)
WHOLE-BODY COUNTERS
description of BNL, for neutron activation analysis in vivo, 25:57785
design and performance of Liege, 25:57764
efficiency and response of, calculation of, 25:57772
performance of various spectrometric, comparison of, 25:57823
WIND
effects of high-level cyclone-type, on radioactive fallout deposition on North America in Jan. 1964, 25:57572(R) (COO-1340-24)
effects on West Valley Processing Plant, safety analysis of, 25:57513 (DOCKET-50201-88)
WINDOWS
design and performance of radiation-shielding glass, for hot cells, 25:58421
WIRES
fabrication of superconducting composite, 25:58951
properties of superconducting composite, 25:58951
WOOD
analysis of pulp for trace amounts of bromine by neutron activation and γ spectrometry, 25:57383
impregnation and gamma irradiation of, computer control system for operating facility for, 25:57628

X

X RADIATION
detection of, sensitivity of semiconductor detectors for, 25:57766
dose planning in therapy, computer programs for, 25:58008
dose to brain during therapy of tinea capitis in children, use of Fricke dosimeter to measure absorbed, 25:58012

dose to gonads and head of patients during full-denture radiography, comparison for conventional and tomographic, 25:58022
dosimetry in human phantom, isodose curves for whole-body, 25:58004
dosimetry in therapy, computer programs for, 25:58020
dosimetry in therapy, computer programs for, 25:58021
dosimetry of, energy calibration of dosimeters for, 25:57859
dosimetry of, performance of Fricke dosimeter for, 25:57862
dosimetry of, standard for design of pocket ionization chamber for personnel, 25:57830
effectiveness for therapy of neoplasms in man, additive effects of electrons on, 25:58076
effectiveness of super-high voltage, for therapy of uterine cervical carcinomas, 25:58070
effects on ability of cells to participate in regeneration of salamander limb, 25:58103
effects on adult, neonatal, and weanling mice, protective effects of tibial shielding against, 25:58110
effects on aminotransferase activity in mitochondria of brain, liver, and heart of adrenalectomized rats, 25:57933
effects on appearance of pseudomicronuclei in progeny of Stylonychia, 25:58096
effects on bacteriophage phi X174, effects of oxygen, nitrogen, and thiourea on mutagenic, 25:57971
effects on barley, protective effects of cysteine, thiourea, and urea against mutagenic, 25:57974
effects on bromomethane, fragment distribution from, 25:57501
effects on carcinomas of human skin, therapeutic, 25:58068
effects on cell division in epidermis of human mammary tumors, 25:58146
effects on central nervous system of rats, effects of focal distance on, 25:58098
effects on cholinesterase and hexokinase activity in brain and heart of rats, effects of adrenal hormones on, 25:57929
effects on chromosomes in seed of Crepis capillaris, effects of time of onset of mitosis on frequency of aberrant, 25:57968
effects on chromosomes of medical personnel, effects of dose and dose fractionation on aberrant, 25:57972
effects on content and ratio of adenine nucleotides of different degrees of phosphorylation in rat liver and kidney, 25:57936
effects on cultured Chinese hamster and human liver cells, effects of incubation in conditioned medium on repair of lethal, 25:58081
effects on DNA and RNA synthesis in amphibian embryos, effects of dose on, 25:57944
effects on DNA of mammalian cells, review of repair mechanisms for, 25:57943
effects on DNA synthesis in polytene chromosomes of Drosophila, 25:57951 (CCC-1747-6)
effects on female gametes and survival of wheat, dose dependence of, 25:58152
effects on flucrine-18 kinetics in fractured bone, 25:58105
effects on formation of immunoglobulin-like proteins in bursectomized chickens, 25:57934
effects on gene and chromosome behavior in parthenogenetic wasps, 25:57962
effects on germ cells of adult, embryonic, and newborn male mice, comparison of frequency of mutagenic, 25:57967
effects on germination and survival of pure and hybrid forms of lupine, comparison of, 25:58149
effects on growth of transplanted sarcomas in mice, effects of dose on, 25:58083
effects on HeLa and melanoma cells, role of cytoplasmic inclusions in, 25:58085
effects on hematopoiesis in mice, effects of partial marrow shielding on, 25:58124
effects on hermaphrodite gonads of Asterina gibbosa, 25:58090
effects on human breast neoplasms, pre-surgical therapeutic, 25:58073
effects on human epithelium following therapy for cervical tumors in relation to recurrance incidence, cytological and histological studies on, 25:58140
effects on human skin following therapy, methods for treatment of ulcerogenic, 25:58038
effects on human tumor surrounding tissues during therapy, effects of body inhomogeneities on, 25:58141
effects on hybrid mice, studies on effects of hematopoietic cells on osteogenic precursor cell transplants using, 25:58121
effects on incidence of mutations for macromelanophores in xiphophorin fish, synergistic effects of hybridization on, 25:57957
effects on incidence of mutations in peas following seed exposure, comparison between neutron effects and, 25:57960
effects on initiation of human umbilical cord leukocyte cell cultures, 25:57921
effects on intestinal mucosa in mice, regeneration following pathological, 25:58111
effects on iodine-131 clearance rate in skin of man and rabbits, 25:58125
effects on life span of Drosophila following exposure of successive generations, effects of genotype on, 25:57961
effects on lungs of man and rabbits, heterotopic bone formation following, 25:58133
effects on macro- and micronuclei of Stylonychia, 25:58096
effects on mammalian cells, review of effects of LET on repair of, 25:58089
effects on mitotic activity in bone marrow cells of laboratory and wild rats, 25:58116
effects on mouse embryos, development of cleft palate and oligodactylia following in utero exposure, 25:58127
effects on neurosecretory cells in crickets, effects of nymph head exposure dose on, 25:58095
effects on neurosecretory cells in hypothalamus of dogs, acute whole-body, 25:58129
effects on numbers of cysteine-rich glial cells in rat brain following head exposure, effects of dose on, 25:58106
effects on orthodromic responses of rats following exposure of spinal cord, 25:58101
effects on phosphorus-32 uptake by bone marrow, liver, and spleen of rats, effects of bone marrow transplants on, 25:58123
effects on rat liver cells, mechanism for, 25:58130
effects on rat tibia, effects of dose on neoplastic and pathological, 25:58102
effects on rats, effects of age and sex on carcinogenic whole-body exposure, 25:58097(T) (ORNL-tr-2521)
effects on reimplantation of human mandible following surgical resection, 25:58132
effects on relation between total iron-59 uptake and uptake by heme and nonheme fractions of bone marrow and spleen of mice, 25:58119
effects on sensitivity of lymphoid cells of mouse bone marrow to antisera, 25:58120
effects on sensitivity of yeast cells to aminopterin, correlation of radiosensitivity with, 25:57927
effects on silica and germania, ESR studies of defects induced in, 25:59174
effects on single crystals or ammonium dioxovanadium(V) bisoxaltate dihydrate, ESR studies on vanadyl ions produced by, 25:57449
effects on skin of rabbits, protective effects of desoxycorticosterone acetate, methionine, and vitamin A against ulceration, 25:58036
effects on small competing populations of Drosophila following exposure of successive generations, 25:57961
effects on sodium chloride crystals, thermal aggregation of F centers in, 25:59152
effects on somatic crossing over in X chromosome of Drosophila, effects of oxygen on, 25:57959
effects on spleen weight in mice, effects of dose fractionation on whole-body, 25:58108
effects on spores of Actinomyces hygroscopicus, effects of hygromycin B and streptomycin on mutagenic, 25:57964
effects on sterility and survival of first and second generation granary and rice weevils, minimum dose for, 25:58161
effects on suppressor mutation induction in Drosophila, localization of chromosome site of, 25:57975
effects on survival of Escherichia coli, effects of anoxia on sensitizing effects of colloidal selenium and selenourea on, 25:58155
effects on survival of mice and rabbits, protective effects of tissue preparations against, 25:58033
effects on thymus of mice, role of bone marrow transplants in recovery from, 25:58115
effects on ultrastructure of cells in thymus gland of mice, 25:58114
effects on ultrastructure of liver cells in salamanders, effects of dose on, 25:58112
effects on yeast, studies on genetic control of mutagenic, 25:57976
emission bursts near plasmapause of 30 keV, correlation with discrete vlf emissions, (E/T), 25:58897
emission from color television receivers, estimation of genetically significant dose to population of USA from, 25:58011
emission from mixed plutonium isotopes, scintillation spectrometer measurement of, 25:57998 (NIRS-Pu-8)
emission from sun of soft, relation to solar activity at other wavelengths, (E), 25:58600
fluence and flux density measurement of low-energy, germanium detector for, 25:57768
intensity distribution of soft cosmic background, (E), 25:58548
production in copper by 12- to 30-keV electrons, depth distribution of, 25:58685
production of cosmic background, (T), 25:58565
scattering from suspensions and slurries, effects of particle size on Compton and Rayleigh, 25:59118
spectra and flux in deep atmosphere, effects of atmospheric scattering and absorption on auroral, (E), 25:58868
spectra of metagalactic, (T), 25:58830
spectra of solar, 25:58583
spectrum and galactic isotropy of cosmic background, (E),

XUM

  25:58650
  transmission through crystals, theory of anomalous, (T), 25:59228
  use for therapy of lung carcinomas, review of complications and effectiveness in sieve and super-high voltage, 25:58137

X-RAY ASTRONOMY
  radiation detection equipment on TD-1, HEOS-B, and COS-B, (E), 25:58829
  research between 1962 and 1970 in, (E), 25:58533
  research in, review of, (T), 25:58565

X-RAY CAMERAS
  development of multiple proportional detector, 25:57774

X-RAY FLUORESCENCE ANALYSIS
  equipment for low-energy, development and performance of lithium-drifted silicon detectors, 25:57816
  particle size effects on, 25:57300 (ORO-3847-2)

X-RAY SPECTROMETERS
  characteristics of silicon avalanche, 25:57771
  design and performance of Compton, for intense pulsed sources in high-level backgrounds, 25:57813
  development and performance of lithium-drifted silicon, for low-energy x rays, 25:57816
  preamplifiers for, application of pulsed feedback techniques to, 25:57812

X-RAY SPECTROSCOPY
  particle size effects on, 25:57300 (ORO-3847-2)

XENON
  determination of radioactive, released from fuel elements by gas chromatography and γ spectrometry, continuous, 25:57344 (CEA-R-4218)
  oscillations in large reactors, calculation of optimum control rod strategy for, (T), 25:60236
  solubility in sodium, 25:58387(R) (ANL-7823)

XENON IONS
  effects on benzene vapor at 60 keV, yields from, 25:57469

XENON ISOTOPES Xe-133
  evaluation for scintigraphy of human lung ventilation, 25:58040 (UCLA-12-834)
  production of gaseous, from neutron-irradiated uranium targets, 25:57485(P)
  use for scintigraphy of human brain for measurement of blood circulation time, 25:58058

Y

YTTERBIUM
  complexes with HEDTA, dissociation constants for, 25:57537
  desorption from tungsten filaments using electric field, 25:58230
  determination in silicate rocks by neutron activation, low-energy photon detector for, 25:57387
  energy levels of, identification of 4f/sup N-1/$6s^26p$ configurations in, 25:58706
  oxidation potential for trivalent--tetravalent, 25:57437
  sorption and desorption from carbonized tungsten, electron-emission study of, 25:58228

YTTERBIUM ISOTOPES Yb-171
  neutron capture by, γ spectra and Q-value for thermal, (E), 25:59825

YTTERBIUM ISOTOPES Yb-172
  energy-level scheme from ytterbium-171 thermal neutron capture, (E), 25:59825

YTTERBIUM ISOTOPES Yb-173
  neutron capture by, γ spectra and Q-value for thermal, (E), 25:59825

YTTERBIUM ISOTOPES Yb-174
  energy levels fom thulium-174 beta decay, spin--parity assignments for, (E), 25:59781 (KURRI-TR-76, pp 19-20)
  energy-level scheme from ytterbium-173 thermal neutron capture, (E), 25:59825

YTTERBIUM OXIDES
  effects on structure of γ-irradiated sodium oxide--tellurium oxide glasses, EPR spectral studies on, 25:57447

YTTRIUM
  determination in presence of scandium using Arsenazo M, spectrophotometric, 25:57318
  determination in rare earth concentrates by neutron activation, 25:57382
  determination in rare earth mixtures by extraction chromatography and emission spectroscopy or neutron activation, 25:57372
  diffusion at 900 to 1300°C, anisotropy in self-, 25:58240
  effects on periodic precipitation in silver--cadmium alloys, 25:58262
  separation from fission products by electromigration following complexing with nitrilotriacetic acid, 25:57558
  separation from strontium by colloid formation and filtration, 25:57352
  thermophysical properties at 20 to 400°C, 25:58225

YTTRIUM ALLOYS AND SYSTEMS
  Ce--Y-base, Kondo temperature and superconducting transition temperature of, effects of pressure on, 25:59195
  Dy--Ho--Y, phase studies of, 25:58274
  Ga--V--Y, phase studies of, 25:58289
  Mg-base--Y, oxide particle identification in, after heat treatment in air, 25:58293

YTTRIUM ISOTOPES Y-89
  deuteron elastic scattering at 80 MeV, optical-model analysis of angular distributions from, (E), 25:59754
  energy levels from strontium-88 (He-3,d) reactions, spectroscopic factors and spin--parity assignments for, (E), 25:59750
  neutron inelastic scattering at 14.8 MeV, cross sections and gamma spectra from, (E), 25:59797
  neutron inelastic scattering at 2.69 to 18.07 MeV, statistical-model analysis of excitation function for, (E/T), 25:59768
  neutron reactions (n,2n) at 13.29 to 17.58 MeV, statistical-model analysis of excitation function for, (E/T), 25:59768
  nuclear charge distribution from electron elastic scattering, (E), 25:59791

YTTRIUM ISOTOPES Y-90
  production of multicurie amounts of, from strontium-90, colloid-filtration method for, 25:57352

YTTRIUM ISOTOPES Y-91
  chemical state in seawater, effects of iron on, 25:57410

YTTRIUM OXIDES
  CaO--Y_2O_3, electric properties of solid electrolytes, 25:59193

YTTRIUM SELENIDES
  dissociation energy of, 25:57435(R) (COO-1029-39)

YUGOSLAVIA
  nuclear power plants in, economics for, 25:60108

Z

ZINC
  determination by extraction using quinolinol melt and spectrography, 25:57312
  determination in pure rare earth oxides, polarographic, 25:57311
  determination of trace amounts of, in clay minerals and soils by resonance neutron activation and γ spectrometry, 25:57375
  determination using sodium azide as supporting electrolyte, polarographic, 25:57307
  diffusion of trace amounts of thallium in molten, thermal, 25:58267
  dislocation interactions in, basal--nonbasal, 25:60267 (CALT-767-P-3-18)
  dislocation mobility at 44°K in, 25:60265 (CALT-767-P-3-16)
  dislocations in, line energy of basal screw, 25:60266 (CALT-767-P-3-17)
  etching by selective cavitation, method for, 25:58190
  mechanical properties of, effects of fatigue on, 25:58223
  microstructure of, effects of fatigue on, 25:58223
  neutron capture at 10 to 80 keV, γ spectra from, (E), 25:59759

ZINC ALLOYS AND SYSTEMS
  Cu--Zn, welding to steel, deposition of intermediate layers for, 25:58204
  In-base--Zn, structure of eutectic of, conditions to produce broken lamellar, 25:58286

ZINC BROMIDES
  hexane--$ZnBr_2$, bromine-80m isomeric transition in, reactions of recoils from, 25:57494

ZINC IONS
  implantation in gallium arsenide at 400 KeV, luminescence study of damage from, (E/T), 25:59141

ZINC ISOTOPES Zn-64
  energy levels from copper-63 (p,γ) reactions, symmetry energy for collective electric dipole, (E), 25:59742
  helium-3 elastic scattering at 30 MeV, optical-model analysis of differential cross sections for, (E), 25:59769
  proton elastic scattering at 40 MeV, differential cross sections for, (E), 25:59739 (ORNL-TM-3591)

ZINC ISOTOPES Zn-65
  content in Columbia River sediments, (E), 25:57561 (TID-25786)
  energy levels and transitions from zinc neutron capture, (E), 25:59759

ZINC ISOTOPES Zn-67
  energy levels and transitions from zinc neutron capture, (E), 25:59759

ZINC ISOTOPES Zn-68
  deuteron elastic scattering at 80 MeV, optical-model analysis of angular distributions from, (E), 25:59754
  deuteron inelastic scattering at 82 MeV, DWBA analysis of angular distributions from, (E), 25:59754
  energy levels and transitions from zinc neutron capture, (E), 25:59759
  energy levels from inelastic scattering, deformation parameters for, (E), 25:59754

ZINC ISOTOPES Zn-69
  energy levels and transitions from zinc neutron capture, (E), 25:59759

ZINC ISOTOPES Zn-70
  neutron reactions (n,2n) at 14.7 MeV, isomer ratio in, (E), 25:59766

XUM

- ZINC OXIDES
  - reactions with silica to form zinc orthosilicate, ESR study of defect kinetics in, 25:59174
- ZINC SILICATES
  - preparation of Zn_2SiO_4 by zinc oxide--silica reaction, ESR study of defect kinetics in, 25:59174
- ZINC SULFATES
  - $CuSO_4$--$FeSO_4$--$Fe_2(SO_4)_3$--$ZnSO_4$, complex ion distribution in aqueous solutions of, 25:57398 (NIM-1093)
- ZION POWER REACTOR, UNIT 1
  - design parameters of, revised and additional data on, 25:59967 (DOCKET-50295-32)
  - operations aspects of, revised and additional data on, 25:59967 (DOCKET-50295-32)
- ZION POWER REACTOR, UNIT 2
  - design parameters of, revised and additional data on, 25:59967 (DOCKET-50295-32)
  - operations aspects of, revised and additional data on, 25:59967 (DOCKET-50295-32)
- ZIRCALOY
  - polishing of, method for attack, 25:58353
  - texture control in tubes of, effects of fabrication parameters on, 25:58186 (ORNL-TM-3500)
- ZIRCALOY-2
  - analysis for cadmium by extraction and photometry, 25:57326
  - fabrication of calandria and pressure tubes of, for Japanese reactors, 25:58194
  - properties for use in encapsulating californium-252, 25:58242
  - properties for use in light water reactors, data tabulations on, 25:58243
- ZIRCALOY-4
  - fabrication of coolant flow regulators of, for BWR systems, 25:58194
  - failure testing of tubes of, deformation and rupture behavior during transient temperature, (E), 25:60118 (ORNL-4727)
  - properties for use in light water reactors, data tabulations on, 25:58243
- ZIRCONIUM
  - analysis for trace amounts of impurities, nuclear reaction and scattering methods for, 25:57360
  - Debye--Waller factor of alpha-, temperature dependence of, (E), 25:59179
  - deposition on tungsten single crystals, field-emission microscopic study of surface structures from, 25:58229
  - determination by extraction using quinolinol melt and spectrography, 25:57312
  - determination by spectrography, elimination of effect of sample composition on, 25:57330
  - diffusion in graphite at 1860 to 2250°C, effects of graphite lattice parameters on, 25:58245
  - diffusion of oxygen in, Wagner's theory on, 25:58254
  - dislocations in alpha-, formation of hexagonal networks of, 25:58288
  - effects on creep strength of aluminum--copper alloys, 25:58239
  - oxidation at low oxygen pressures, thermogravimetry studies on kinetics of, 25:58175
  - oxidation of, Wagner's theory on, 25:58254
  - properties for use in light water reactors, data tabulations on, 25:58243
  - separation from oxalic and tartaric acids by solvent extraction using tributylamine, 25:57546
  - separation from plutonium by solvent extraction using TBP, 25:57357
  - separation from thorium by ion exchange, 25:57342
  - separation of berkelium from, by sorption on zirconium phosphate--silicate, 25:57530
  - surface nitridation of, effects of nitrogen purity on, 25:58173
- ZIRCONIUM ALLOYS AND SYSTEMS
  - analysis for niobium using magneson, photometric, 25:57315
  - development of high-temperature, use of diffusion coefficient as guide for, 25:58208 (AECL-3967)
  - mechanical properties of fuel cladding and pressure tubes of, 25:58209 (AECL-3992)
  - plastic instability of tubes of, 25:58209 (AECL-3992)
  - polishing of, method for attack, 25:58353
  - preparation of reference specimens of, methods for, 25:58179 (CONF-711002-, pp 47-58)
  - properties for use in heavy water reactors, 25:58217 (ZJE-107)
  - testing of fuel cladding of, closed-end burst, 25:58209 (AECL-3992)
  - testing of, in-reactor stress relaxation, 25:58209 (AECL-3992)
  - welding of, methods for, 25:58188 (ZJE-110)
  - C--Cr--Fe--Hf--Mo--Mn--Nb--Ni-base--Si--Ti--Zr, radiation effects on mechanical properties of, relations of composition with thermal neutron, 25:58168 (ORNL-4676, pp 139-233)
  - C--Mo--Zr, phase studies of, 25:58273
  - Co--Zr-base, properties of dilute cast, electric and mechanical, 25:58258
  - Cr--Zr-base, properties of dilute cast, electric and mechanical, 25:58258
  - Fe--Zr-base, properties of dilute cast, electric and mechanical, 25:58258
  - Hf--Zr, liquidus and solidus curves for, calculations for, 25:58292
  - Mn--Zr-base, properties of dilute cast, electric and mechanical, 25:58258
  - Mo--Nb-base--Zr, machining characteristics of, at high and low temperatures, 25:58198
  - Mo--Sn--Ti-base--Zr, tensile properties of Beta III, at room temperature, 25:58234
  - Mo-base--W--Zr, mechanical properties and recrystallization temperature of, effects of tungsten and zirconium contents on, 25:58248
  - Nb--Zr-base, fabrication of calandria and pressure tubes of, for Japanese reactors, 25:58194
  - Nb-base--Zr, radioinduced void formation in, neutron, 25:58300 (ORNL-TM-3496)
  - Ni--Zr-base, properties of dilute cast, electric and mechanical, 25:58258
  - Ti--Zr-base, properties of dilute cast, electric and mechanical, 25:58258
  - U--Zr, liquidus and solidus curves for, calculations for, 25:58292
  - V--Zr-base, properties of dilute cast, electric and mechanical, 25:58258
  - Zr--ZrC-base, residual stresses in, effects of cyclic temperature changes on, 25:58381
- ZIRCONIUM BOROHYDRIDES
  - mass spectra of $Zr(BH_4)_4$, 25:58377
- ZIRCONIUM CARBIDES
  - crystallization following annealing at 1600 to 2000°C, mechanisms of, 25:58394
  - Zr--ZrC-base, residual stresses in, effects of cyclic temperature changes on, 25:58381
- ZIRCONIUM CHLORIDES
  - effects on nitrification by Nitrobacter agilis in soil suspension, 25:57401
- ZIRCONIUM HYDRIDES
  - crystal lattice phases in, relations with density, 25:58402
  - sorptive properties of delta-phase, for hydrogen at 650 to 800°C, kinetics of, 25:58373
  - vibration spectra of, pulsed neutron-scattering of, 25:58384
- ZIRCONIUM ISOTOPES Zr-90
  - nuclear charge distribution from electron elastic scattering, (E), 25:59791
  - proton inelastic scattering by, approximate G-matrix calculations for, (T), 25:59858
- ZIRCONIUM ORES
  - separation of hafnium from sulfate solutions from treatment of, by extraction with cyclohexanone solutions of thiocyanic acid, 25:57533
- ZIRCONIUM OXIDES
  - analysis for trace amounts of metals, effects of halide additives on direct spectrographic, 25:57335
  - diffusion of oxygen in, effects of pressure on, 25:58370
  - diffusion of oxygen in, Wagner's theory on, 25:58254
  - oxidation of, Wagner's theory on, 25:58254
  - performance as high-temperature heating elements in furnaces, 25:58357
  - vaporization of calcium oxide-stabilized, in air at 1900 to 2200°C, 25:58345
  - $AlPO_4$--ZrO_2, performance as protective coatings on metals exposed to high-temperature flowing gases, 25:58375
  - CaO--ZrO_2, electric properties of solid electrolytes, 25:59193

XUM

REPORT NUMBER INDEX

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If published proceedings are received after the receipt of individual papers, the complete proceedings will be abstracted and the abstract number will appear in this index with the base CONF number.

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	25-59834	See KURRI-TR-76
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CONF-691066-	(VGB Feedwater Conference, Essen, Germany, Oct. 7-8, 1969)	
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Report No.	Abstract No.	Availability
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4	25-58960	See CEA-CONF-1831
5	25-59025	See CEA-CONF-1832
6	25-59012	See CEA-CONF-1833
7	25-58978	See CEA-CONF-1829
8	25-59061	See CEA-CONF-1828
9	25-59084	See CEA-CONF-1827
10	25-59083	See CEA-CONF-1826
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XUM

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97	25-59956	See DOCKET-50271-63
98	25-59944	Dep. NTIS, 55p.
99	25-59912	Dep. NTIS, 6p.
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DOCKET-50254- (Quad-Cities Station; See also DOCKET-50265) (Non-AEC)		
53	25-59949	Dep. NTIS, 33p.
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DOCKET-50261- (H. B. Robinson) (Non-AEC)		
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DOCKET-50266- (Point Beach Nuclear Plant) (Non-AEC)		
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50	25-59961	See DOCKET-50280-51
51	25-59962	See DOCKET-50280-52
DOCKET-50282- (Prairie Island Nuclear Generating Plant, See also DOCKET-50306) (Non-AEC)		
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40	25-59963	See DOCKET-50282-41
DOCKET-50309- (Maine Yankee Atomic Power Company) (Non-AEC)		
42	25-59956	See DOCKET-50271-63
DOCKET-50311- (Salem Nuclear Generating Station--Formerly Burlington Nuclear Generating Station, See also DOCKET-50272) (Non-AEC)		
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49	25-59973	See DOCKET-50315-49
DOCKET-50317- (Calvert Cliffs Nuclear Power Plant, See also DOCKET-50318) (Non-AEC)		
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29	25-59975	See DOCKET-50317-29
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23	25-59951	See DOCKET-50261-74
DOCKET-50325- (Brunswick Steam Electric Plant, Units 1 and 2, See also DOCKET-50324) (Non-AEC)		
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